City of Buffalo, NY
Broadband Infrastructure Inventory Study

December 09, 2021

ECC
TECHNOLOGIES

FINAL REPORT

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City of Buffalo, NY
Broadband Infrastructure Inventory Study

Created for

Buffalo Urban Renewal Agency (BURA)

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1. Introduction

Broadband access has become one of the foundational resources that allows a community to compete and thrive in the 21st century. Infused into all aspects of our social and economic life, broadband connects computers, cell phones, televisions, appliances, and most modern technology.

Broadband powers emails, Internet searches, social media, online shopping, and information management. It enables business, education, medicine, government, and public safety to perform their functions efficiently. It is a critical component of economic development and a community's ability to attract and retain industry. Recent surveys show high-speed broadband is now as important to attracting businesses and job creation as good transportation, power, water, and skilled labor.

Telecommunications infrastructure and broadband service have transformed the way people, public organizations, and companies communicate, educate, work, and live. Broadband, and the fiber optic backbones that support it, has undeniably become the "interstate highway" of the 21st century.

The use of broadband service is becoming ubiquitous. By 2023, North America will have 345 million Internet users (92 percent of regional population), up from 328 million (90 percent of regional population) in 2018.[1]

Broadband today is considered infrastructure as critical as roads, electricity, and water. Inadequate broadband has become a barrier to community growth, competitiveness, and economic development. This has led to something called "The Digital Divide."

The Buffalo Urban Renewal Agency (BURA) in partnership with the City of Buffalo has commissioned this study in part to understand its city's broadband availability and explore opportunities for possible broadband expansion to help the city overcome this Digital Divide.

1.1 The Digital Divide

On Feb 8, 1996, the Federal Communications Commission (FCC) created the Telecommunications Act to establish competition and facilitate growth in the telecommunications industry, which previously had been a government-regulated monopoly.

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[1] https://www.cisco.com/c/en/us/solutions/collateral/executive-perspectives/annual-internet-report/white-paper-c11-741490.html

After the Telecommunications Act, telephone companies called Competitive Local Exchange Carriers ("CLECs") emerged and were able to provide consumers with a choice of services. During this period other non-traditional telecommunications companies such as cable TV providers, network providers, and wireless providers (both cellular and fixed wireless) began to offer competitive broadband services to participate in the explosive growth of the Internet.

DIGITIAL DIVIDE. Over twenty-five years have passed since the 1996 Telecommunications Act which succeeded in creating competition and increased availability of broadband access. Despite that success, a technology gap has occurred between communities that have access to affordable broadband service and/or adopt its use and those that do not. This division, known as the Digital Divide, has split communities into broadband "haves" and "have nots."

The most recent Federal Communications Commission ("FCC" or "Commission") 2020 Communications Marketplace Report released December 31, 2020, states 74% of people have access to at least two options of fixed broadband at speeds of least 25/3 Mbps[2]. Broadband speeds are measured in **'megabits per second'**, often shortened to Mbps. Bits are tiny units of data, with a megabit representing a million of them. The higher the number of Mbps (megabits per second) you have, the higher speed your online activity should be. The report, however, does not assess whether the broadband service options are affordable. Affordability can be a primary obstacle to adoption of broadband. For instance, if a household has access to broadband service and if the broadband plans associated with that service are not affordable, it is the equivalent to having no access to that service at all.

The FCC also evaluated fixed broadband adoption rates between the years of 2015 and 2019. In urban areas, 73% of homes adopted broadband at speeds of at least 25/3 Mbps. Evaluating the same benchmark speeds in rural core areas, only 65% of households adopted broadband. The numbers are even lower for Tribal lands where only 47% of households have reliable access to minimum broadband speeds.

Difficulty in deploying rural infrastructure often overshadows urban issues. Still, at least 13.9 million urban households are without broadband, wired or wireless, more than three times the 4.5 million rural households that lack a broadband subscription.

It is easy to assume bustling urban communities and well-developed suburbs are already well served by broadband. However, there are often significant gaps in infrastructure that fail to connect low-income urban areas or new developed outlying metropolitan areas. The Department of Housing and Urban Development's Community Development Block Grant Program is an example of an initiative that helps to support broadband infrastructure deployment in urban areas. These grants help build the last mile connections to new and existing housing developments that may not be easily accessible to providers. Without this type of investment, these communities would remain at a distinct disadvantage when it comes to distance learning, telehealth, and other activities that are required for meaningful participation in a digital society.

Similarly, in rural America, there is an assumption that broadband connections are not available, preventing rural households from being able to get online. However, income and affordability also play a significant role.

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[2] FCC 20-188 2020 Communications Marketplace Report December 31, 2020

While broadband continues to remain a priority for local officials, as well as state and federal lawmakers, funding for broadband deployment must evolve to meet the new challenges that communities face when working to connect their residents. Promoting infrastructure deployment in rural areas, while ignoring obstacles to adoption in communities of all geographies and sizes keeps the digital divide alive. Many urban areas are characterized by areas of lower household incomes. Although many of these areas often offer good accessibility to broadband, many times there is limited choice and high cost for service.

In many instances, the difference between a household that has access to broadband service and one that does not can be less than a few hundred feet, but the cost to overcome this short distance can be more than a resident or business can afford. In addition, pricing, knowledge, and available education on the use of the Internet is a real barrier to adoption.

Increasingly, digital adoption issues are getting more attention. Pricing, access to devices, and digital literacy prevent millions of Americans from getting online. As harder to reach communities can access infrastructure, they will contend with similar issues complicated by the reality that rural broadband service is frequently offered at a prohibitively high price to recoup the costs of deployment. Unfortunately, federal programs do not address adoption issues, only infrastructure development.

OLDER INFRASTRUCTURE. Despite the increased need for broadband service, many areas of the country still rely largely on copper-based infrastructure such as the incumbent telephone companies' unshielded twisted pair copper wire or satellite connections for broadband connectivity.

Much of the infrastructure in place today in these areas has been in operation for more than 50 years. Unfortunately upgrading copper's limited bandwidth to the high bandwidth capacity of fiber has not been an area of focus for the telecommunications industry. This is due mainly to the high cost of installing fiber. Furthermore, the incumbent broadband providers are reluctant to invest in expensive telecommunications infrastructure upgrades, which do not show short term profitability.

1.2 Efforts to Close the Digital Divide

There are several federally subsidized rural area programs to expand local incumbent provider broadband such as the Connect America Fund (also known as CAF), the Rural Digital Opportunities Fund (RDOF) and the USDA ReConnect program. However, as broadband is not a publicly regulated service, like telephone service, there are no obligations for the providers to make new broadband investments in unprofitable areas.

Unfortunately for the most part these "rural focused" programs have not had a sizeable impact on cities such as Buffalo, which are discussed later in this report. However, there are several other programs, currently underway, that may have a significant impact on the Buffalo area. These initiatives include:

IGNITE Fruit Belt Initiative

In the spring of 2021, the University of Buffalo and the not-for-profit organization Ignite received federal grant funding to implement wireless high-speed Internet in an underserved area of Buffalo known as the Fruit Belt neighborhood. When completed 150 homes are estimated to be impacted by this initiative. The

award was part of a larger $2.7 million effort called Project Overcome which is focused on providing Internet service to underserved communities[3].

The Fruit Belt neighborhood has been described as one of the most underserved areas in the city. The initiative is utilizing four wireless tower locations with the main access point on the Buffalo General Hospital building. Crown Castle, a national fiber and tower company, is donating a landline backhaul circuit for 1 year to the program.

The planned solution is based on a point to multi point fixed wireless network consisting of Telrad fixed wireless equipment as the distribution. This equipment will utilize the LTE (Long Term Evolution) CBRS Citizens Broadband Radio Service) frequency 3.55 to 3.7 Ghz and have a range of 0.6 to 1 mile from the point of origin.

It is estimated that the network will provide 800 Mbps (200 X 4 antennas - sectors) total bandwidth with a minimum of 25/3 Mbps to the home. However, it is believed the system is capable of providing up to 55 Mbps per home when fully implemented.

ErieNet

In 2017 Erie County hired an outside consulting firm (ECC Technologies) to inventory and assess the County's broadband environment. One of the recommendations from that report was the development of an open access (OA) dark fiber network that would create fiber rings around the entire County.

At this time ECC is developing a Business Plan to determine if an Open Access fiber network is financially sustainable in the County based on several market variables including stakeholder interest, underserved areas and more.

If built, this network will be the foundation for service providers to enter the Erie County area and expand broadband availability and competition. The network will include fiber segments running into and emanating out of the City of Buffalo. The availability of ARPA funds, discussed next, has made it possible for many local government organizations to consider these types of initiatives.

Over the past decade a number of these Open Access networks have been built, operated, and proven to be very successful in the state of New York. Examples of these include the Ontario County fiber system and Southern Tier Network (STN). STN operates in Chemung, Schuyler, Steuben, Allegany, Tioga, Tompkins, Broome, and Yates Counties. The ECC Business Plan report is scheduled to be delivered to the Erie County representatives on or before Feb of 2022. The County is in the process of creating a not-for-profit local development corporation called ErieNet to own and operate this middle mile open access fiber network.

American Rescue Plan (ARP) Funding

On March 11, 2021, a national based $1.9 trillion COVID-19 relief package was signed into law. Included in this funding is money that can be used for broadband infrastructure development at state and local levels.

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[3] http://www.buffalo.edu/ubnow/stories/2021/04/fruit-belt-internet.html

The federal government made available $350B in what it calls the Fiscal Recovery Fund. This fund is split 60% for the states and 40% for local government. In actual dollars that equates to $219.8 billion that will be distributed to states, as well as the $130 billion for local governments and counties.

State and local governments can use some of this funding to meet local needs including broadband development. The US funding response to COVID has provided what many are calling a once in a lifetime opportunity to tackle the digital divide, both from an infrastructure and adoption perspective.

Since this money is tied to federal funds there are federal rules that will apply.

Dated June 24, 2021, the Interim Final Rule states "eligible projects to reliably deliver minimum speeds of 100 Mbps download and 100 Mbps upload. In cases where it is impracticable due to geographically and financially feasible the speeds can be 100/20 Mbps with the ability to upgrade."

Underserved areas are defined as locations where they do not have wireline connection that reliably delivers at least 25 Mbps download speed and 3 Mbps of upload speed. The term reliably has yet to be defined. In addition, under this program not all homes in designated unserved or underserved area need to be served today.

All costs of projects must be incurred by December 31, 2024, with overall completion dates no later than the end of December 2026 for projects funded with the Fiscal Recovery Funds. Funds may be used for middle mile and/or last mile projects, with a focus on getting last mile services put in place.

New NY Grant Program

In 2015, New State announced the New NY Grant program. The program had three rounds of grant applications and funding. To date, over $162K have been invested in broadband expansion in the city of Buffalo through the New NY Broadband Program. Since 2015, only one broadband provider has been awarded grants in city of Buffalo, that provider is HughesNet a satellite company. The grant awards, respective investment and locations served are listed in Table 1 below.

Awardee	State Grant	Total Investment	Locations
Hughes Network Systems (Buffalo)	$107,100	$161,795	664
Hughes Network Systems (Village of Blasdell)	$315	$450	2
Total	$107,415	$162,245	666

TABLE 1 NEW NY BROADBAND GRANT AWARDS (ROUNDS 1, 2 & 3) IN BUFFALO

A graphical representation of the census blocks awarded grant funding by the New NY Broadband Grant program is shown in Figure 1 on the next page. It should be noted that the areas awarded to HughesNet through the New NY Boradband Grant were awarded to provide service to areas such as the Tifft Nature Preserve, South Park, the Outer Harbor, Grover Cleveland Golf Course, University at Buffalo South Campus to name a few. These awards do not appear to be effective at providing any broadband improvemebnt to the city of Buffalo as satellite service was already available there.

Satellite service is a form of broadband. Unfortunately, satellite service can be impacted by weather and has high latency, which can be detrimental to Voice Over IP, gaming, and video services. Further, satellite service is relatively expensive with capped data usage. Once the cap is surpassed for a given month, speeds are significantly lowered or throttled down.

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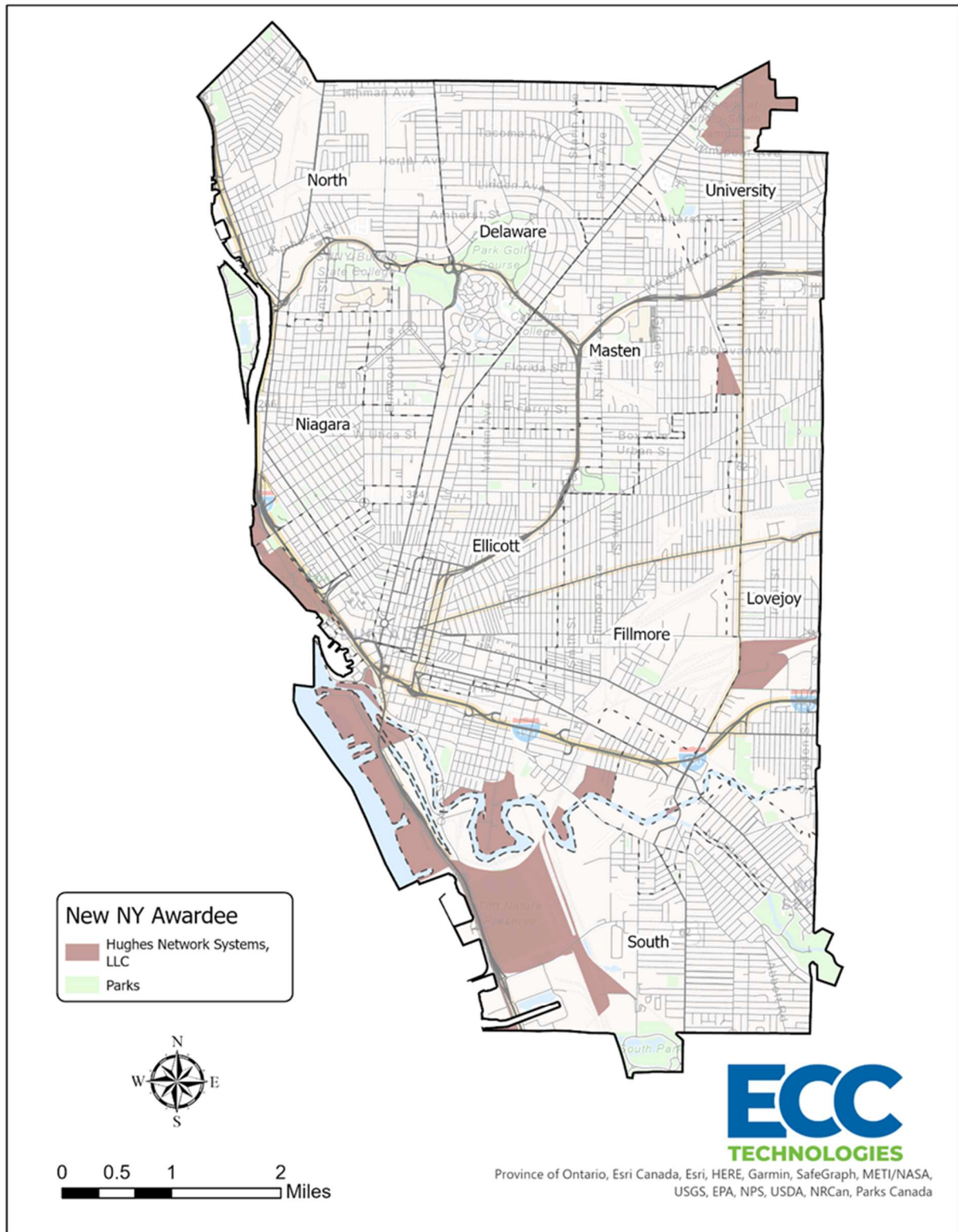
FIGURE 1 NEW NY BROADBAND GRANT AWARD CENSUS BLOCKS

Regional Digital Opportunity Fund (RDOF)

Early in 2021, the FCC RDOF program replaced the FCC CAF program. This new $20.4B grant program is based on two separate reverse or "lowest bid wins" auctions. The first auction was held in October of 2020 and targeted census blocks that are wholly unserved with fixed broadband at speeds of at least 25/3 Mbps.

The sole award winner in the City of Buffalo is Space Exploration Technologies Corporation, or as it is better known SpaceX. The second auction date has not been set.

RDOF Awarded areas are shown in Figure 2. The red areas represent awarded areas to SpaceX. SpaceX will be launching and utilizing next generation low earth orbit satellites to provide at least 25/3 Mbps service. This new service is called Starlink and is currently in beta testing.

The Starlink website claims speeds available will be between 50Mb/s and 150Mb/s. However, a clear line of sight ("LOS") between the Starlink receiver dish and the satellite needs to be available. Unlike terrestrial fixed wireless services, weather can impact the performance of the connection.

The RDOF grant award amount is paid out to the winning bidder as annual installments over a 10-year period. Under the RDOF rules the service provider winning the award has three years to complete 40 percent of their build and six years to complete the full build out.

According to the posted award information, Space Exploration Technologies Corporation will service 10 locations via their low earth orbit satellite broadband service. Clearly, this award providing minimal impact to the city of Buffalo providing service to areas that include the Buffalo Harbor State Park, Port of Buffalo Small Boat Harbor, RCR Yachts, and CSI Sands, LTD.

Awardee	Assigned Support (10 years)	Locations	Pct of Locations
Space Exploration Technologies Corp	$3,914	5	Above Baseline (25/3)
Space Exploration Technologies Corp	$5,194	5	Above Baseline (25/3)
Total	**$9,108**	**10**	

TABLE 2 RURAL DIGITAL OPPORTUNITY FUND GRANT AWARDS IN BUFFALO

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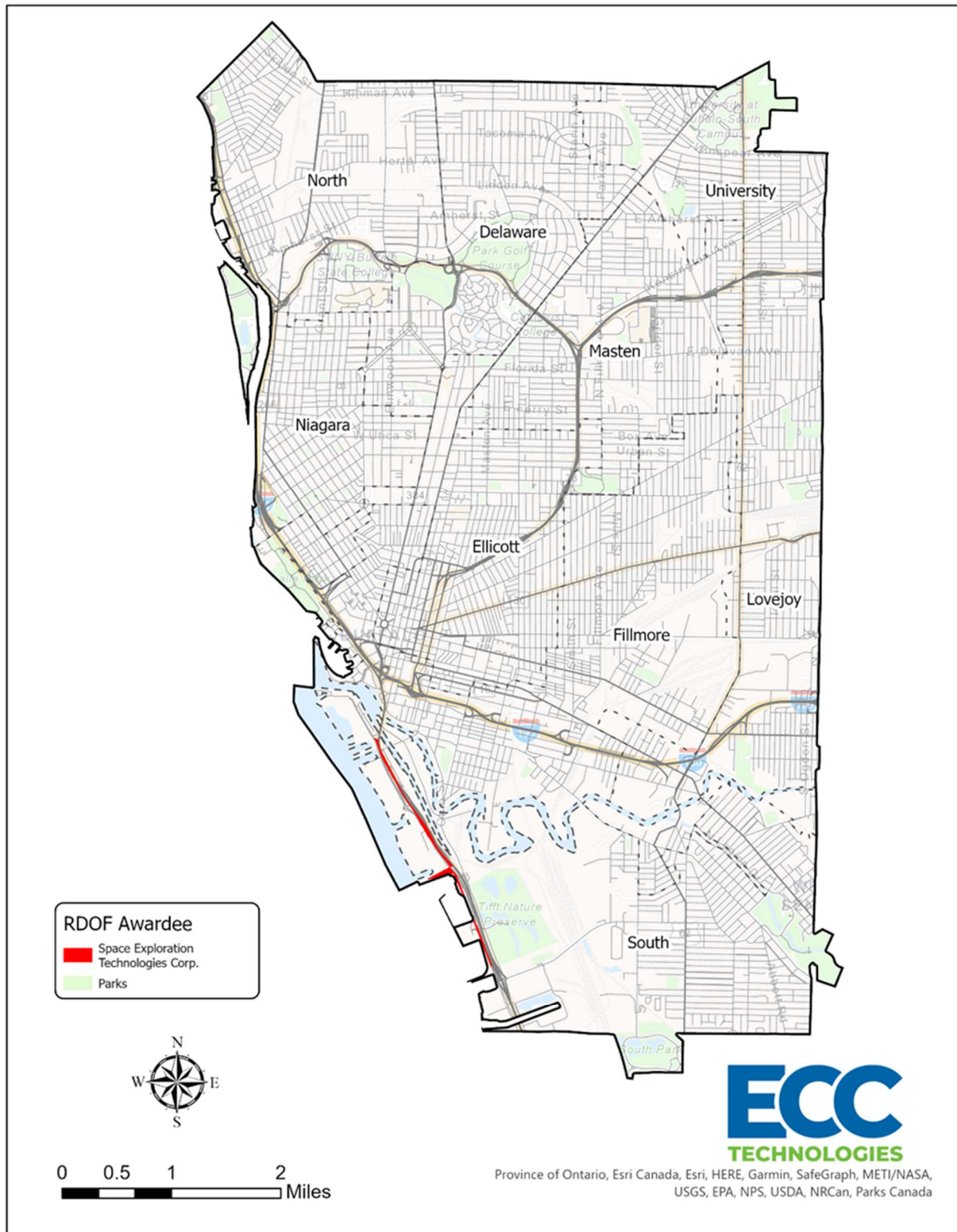
FIGURE 2 RDOFF AWARDED CENSUS BLOCKS

The Need for Broadband

Communities today increasingly compete to become a "Gigabit Community," which is the new standard for areas that want to attract the people, jobs, businesses, and the investments of the future.

Community involvement towards this goal enables the development of mutually beneficial partnerships involving organizations such as counties, cities, electric companies, alternative broadband providers, and more, enabling new investments in broadband infrastructure.

These organizations can make long-term investments to improve their communities, and the Digital Divide is being bridged by communities that are willing to plan and cooperate to reach their growing broadband needs.

According to NYS the entire City is now served by sufficient broadband. However, the federal government does not recognize the current generation of satellite service as sufficient to be considered served. With that said, the FCC is awarding next generation satellite service to satellite companies through its RDOF Grant program.

Although the City is served by at least CATV and DSL, some areas of the city have Fiber to the premise available. The issue raising a great challenge for the city is in its vast underground infrastructure and the ease and timeframe required for carriers to access the underground conduit or construct their own.

COVID-19.

The world moved into lockdown to protect against the spread of the COVID-19 virus. This caused a major shift in the way we perform critical tasks including work from home (video conferencing and collaboration, virtual private network access to company systems), learning from home (video conferencing and collaboration and access to e-learning platforms), and telemedicine (video conference with healthcare professionals and access to healthcare systems).

Covid also had impacts on daily activities including shopping (ordering food and items for delivery or curbside pickup) and entertainment (video streaming, online gaming, social media). As a result, fixed broadband traffic increased up to 60%, voice traffic increased up to 130% and Wi-Fi calling increased up to 80%.

The situation has brought to light the importance of remote healthcare, remote learning, and remote work. The COVID-19 pandemic has exposed the nation's persistent broadband issues including availability, affordability, and speed of service exponentially.

As many people have been quarantined in their homes, lack of access in residential areas is getting unprecedented attention with newly announced grant programs from both federal and state agencies. These grant programs define underserved and unserved by the availability of set download and upload speeds. Understand what is available is more important now than ever.

The cross referencing of field study data with the results of a Broadband Availability & Adoption Tool (BAAT) campaign will further help define areas of need in a more granular manner and provide a basis from which to obtain partners and funding. This will be discussed in the summary BAAT campaign information at the project closeout.

In 2015, the FCC set the standard for broadband access at 25Mb/s download by 3Mb/s upload. A new standard of 100Mbps download is being discussed among industry analysts. Four US Senators called upon the Biden Administration to establish a "21st century definition of high-speed broadband" of 100Mb/s both download and upload. The FCC is likewise supporting a new standard above the current one. The map on the following page shows all of Buffalo is considered served under the current standards.

However, as shown in the study's mapping information, pockets of areas across the city would benefit from additional service and competition. Information in this report can be used to help the city of Buffalo lessen the Digital Divide.

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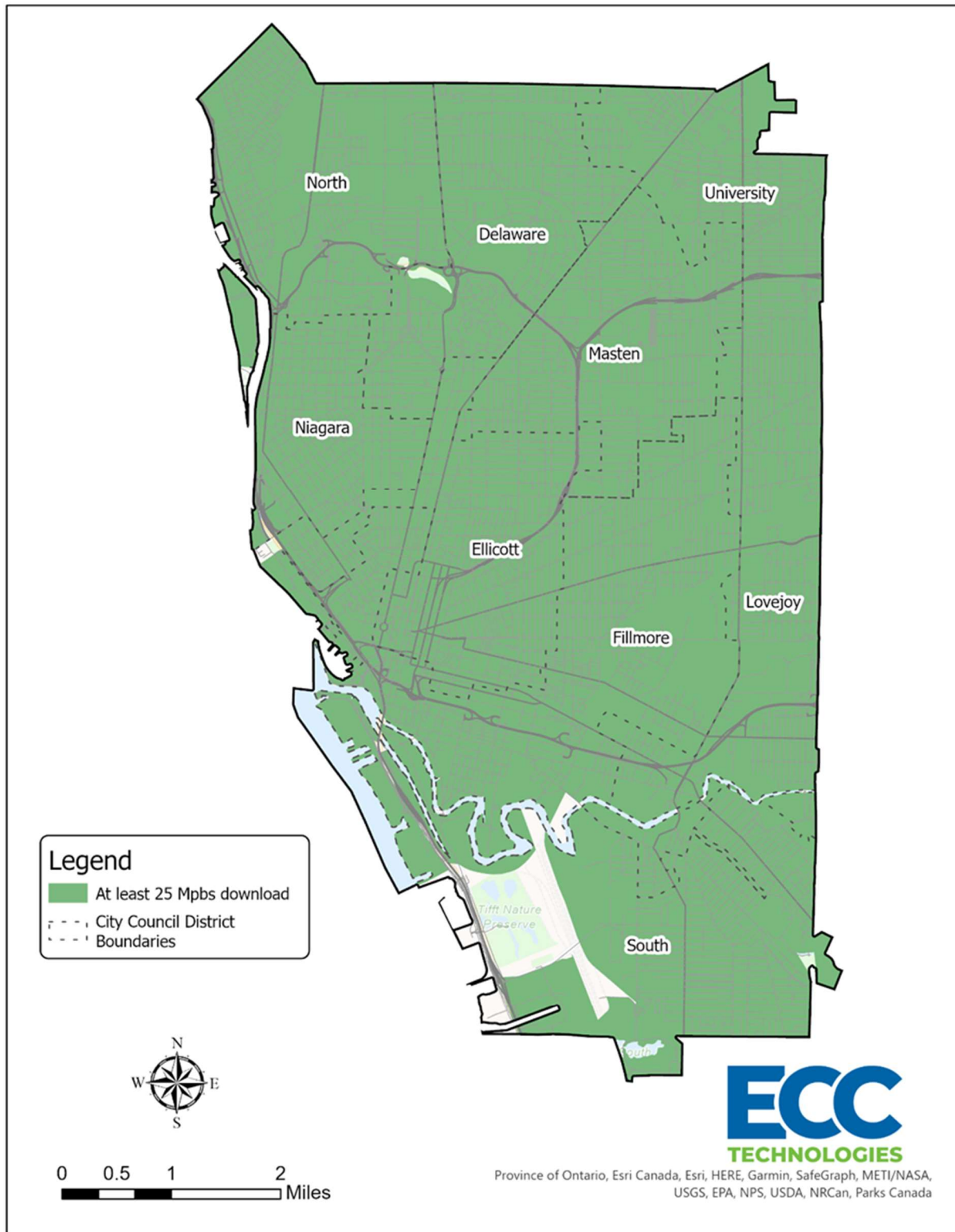
FIGURE 3 FCC 477 DATA OF CENSUS BLOCKS REPORTING AT LEAST 25MBPS/3MBPS

1.3 Purpose of the Project

In February of 2021, BURA contracted with ECC Technologies, Inc. (ECC) to perform a telecommunications study by conducting an inventory of existing fiber optic, coaxial assets and other broadband supporting infrastructure and needs assessment within the City of Buffalo, NY.

One of the main focuses of the study was to identify general areas of the city that are lacking in broadband infrastructure and service. In addition, the data collected from this effort will be used in the next steps to develop a technological solution to address the lack of broadband in unserved and underserved areas of the city, obtain partners, and funding to address these issues.

The inventory section of the project included a high-level field inventory of the City's existing broadband infrastructure, namely the fiber optic, coaxial cable, and tower infrastructure. ECC's outside plant (OSP) team drove the main roads in the city and to the extent possible, physically identified and documented the City's existing broadband infrastructure. As per the agreed upon scope of work, ECC did not drive secondary and neighborhood roads. The ECC team, with the field data gathered, created maps of the City's infrastructure into an ESRI GIS database.

In phase 2, concurrent with the inventory study, ECC conducted a broadband survey campaign within the city limits. Our Broadband Availability and Adoption Tool (BAAT) is a web-based application that documented 1) demand for broadband services, with the marketing component, data, and 2) mapped responses all captured within one portal. (In a separate report provided to BURA, our BAAT responses helps identify many of the obstacles to adoption for residents who already have access to broadband services but choose not to subscribe. And it helps determine paths to address those issues.)

During phase 3 ECC met with community groups to identify and document their current and future broadband needs. ECC documented the communications goals of their organizations, as well as their willingness to support broadband expansion efforts.

This general infrastructure and needs assessment report document our findings. ECC has identified the different broadband providers in the area and describes their current levels of fiber and coaxial infrastructure, based on the high-level OSP study. ECC has created maps documenting the fiber, coax, and tower infrastructure found in the city.

These maps consist of the following information, and will serve as the foundation to overlay future City Initiatives:

1.   Fiber optic cabling
2.   Coaxial cabling
3.   Central Office
4.   Wireline boundaries
5.   Wireless tower and water tower sites

The inventory includes critical broadband access/telecommunications infrastructure information that can lay the foundation for broadband improvement plans.

The information compiled by ECC Technologies is presented in the following pages of this report. Much of this information has also been placed into an interactive electronic geographic information system (GIS) database and provided to BURA.

This database tool consists of interactive mapping elements that can be used to identify and locate the major telecommunications resources within the area for economic development and City planning purposes.

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2. Research and Project Methodology.

2.1 Research Methodology

To gather the information required for the study, ECC researched the major telecommunications provider types listed below and performed field surveys. In these field surveys an ECC designer traveled the main roads in the city and sampled some secondary roads to identify and document outside plant (OSP) infrastructure.

The following were identified:

1. Incumbent Local Exchange Carriers (ILECs)

2. CATV Cable TV/Modem Service Providers

3. Competitive Local Exchange Carriers (CLECs)

4. Network Services and Dark Fiber Providers

5. Communications Towers and Owners

Secondary research utilized publicly available databases managed by federal and state agencies and information purchased from telecom industry database research organizations.

Primary research was conducted by outside plant personnel field surveys for fiber optic and coax route identification via aerial and underground markers, networking equipment and tower locations.

ECC also obtained telecommunications industry data publicly available from the following federal, state, and local organizations: the FCC, PSC, and other sources.

Other resources included certain databases to which ECC has access, telecommunications industry research companies, telecommunications provider websites, and telecommunications industry professionals.

During the field study it was noted that ILEC's are no longer marking their buried fiber cables as "Buried Fiber Cable." All new installations are simply being marked as "Caution: Buried Cable." This is being done to avoid giving competitors the locations where the ILECs are expanding/deploying new fiber services.

The map of Figure 4 on the next page illustrates the roads driven as part of the ECC OSP work.

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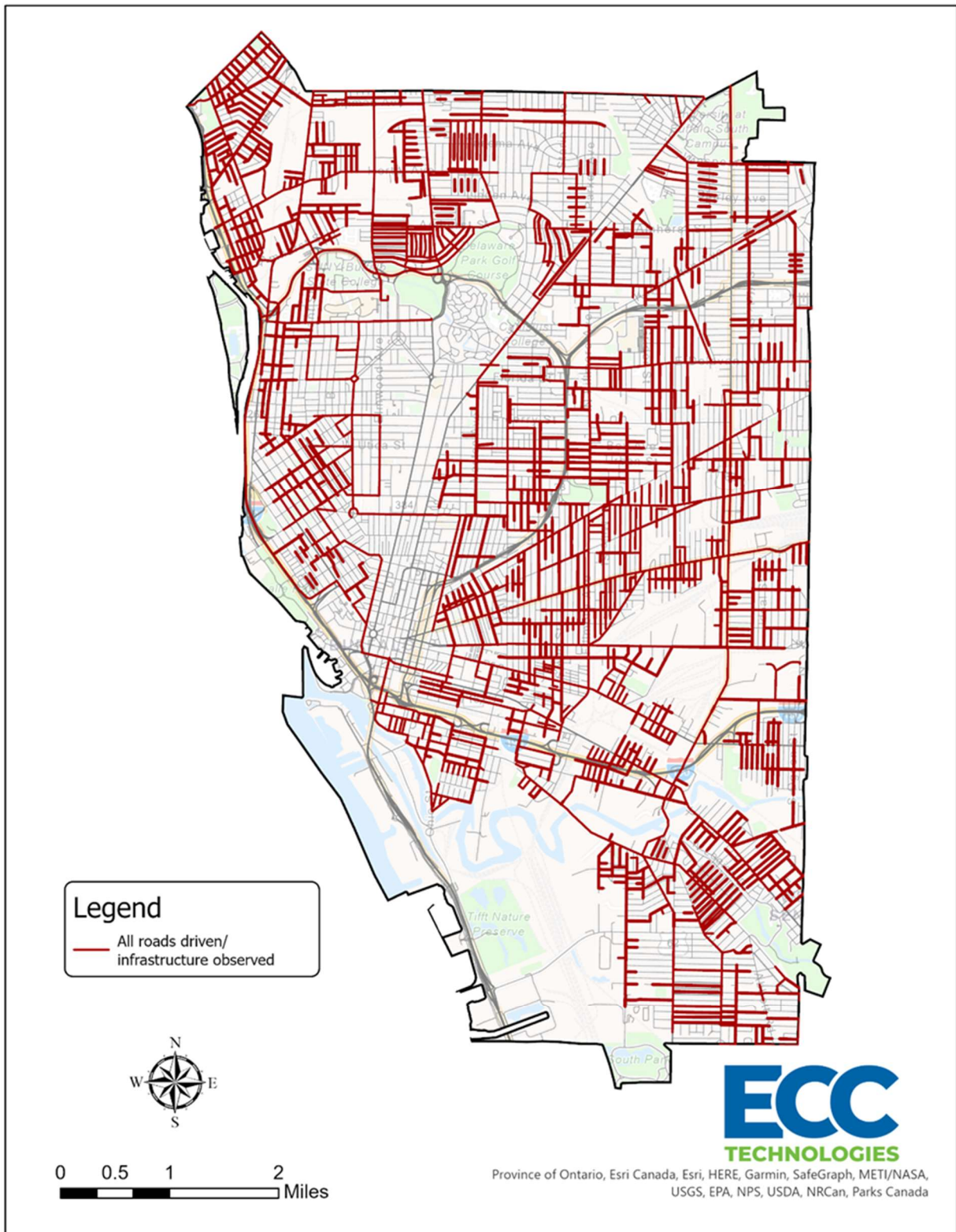
FIGURE 4 ROADS DRIVEN DURING OSP FIELD STUDY

2.2 GIS Mapping/Database

All infrastructure information discovered in the inventory phase has been integrated into a GIS model developed for and provided to BURA. This GIS database will be administered, stored, and updated by BURA staff to ensure security and continuity of the resource.

The GIS database of information was developed to support broadband and economic development initiatives. This information will be used by BURA and the City Planning Department for city and local district level use. The maps included in this report represent examples of the area's fiber optic cable, coaxial cable and vertical asset infrastructure documented in this study.

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3. Broadband Infrastructure Overview

This section is an introduction to the major providers and different types of infrastructure used in the city to deliver broadband service. A summary map that shows the available and important infrastructure is also included.

The broadband providers in city of Buffalo are delivering service to homes, businesses, and other organizations at varying degrees of access, performance, and cost. The infrastructure in use by the industry include landlines consisting of copper, coaxial, fiber optic, or wireless based technology utilizing strategically placed towers and satellite.

3.1 Wireline Infrastructure – Copper, Coaxial, and Fiber Optic

Wireline infrastructure includes telephone and cable TV cables, which are either buried in the ground or attached aerially to utility poles. Wireline cables can be twisted pairs of copper wire, coaxial, or fiber optic cable.

The wireline infrastructure for the city is primarily owned and operated by the incumbent local exchange carrier which is Verizon and the cable provider which is Spectrum Communications. Others include Crown Castle, FirstLight, Century Link and Windstream who are fiber-based providers per the FCC 477 report.

Digital Subscriber Line (DSL) Service.

Traditional telephone copper cable is still the most used infrastructure serving homes and businesses across the city. Copper cable is used by the telephone companies to connect Central Offices to end users for the purpose of providing traditional voice and data services, typically referred to as broadband.

Copper cable has a very limited capacity for broadband service and is usually the reason why advanced telecommunications services are not available in certain areas. The limitations of copper based providing broadband is a direct result of distance from the home to the Central Office or Remote Terminal, the age, and the restrictive performance qualities inherent to the wire itself.

Most of the residential telephone service in the city is supplied by copper cable that consists of numerous pairs of unshielded twisted pair (UTP) copper wires. To provide a faster service over existing copper lines, the telephone carriers have developed digital services called DSL, or "digital subscriber line" technology, which is considered by some a low-end form of broadband.

ADSL (Asynchronous Digital Subscriber Line) is a form of DSL Service that provides download speeds that are different and typically greater than the upload speeds. ADSL uses an ordinary UTP line to deliver bandwidth services of up to 24Mbps service (and sometimes more), depending on the type of ADSL and the distance from the point of equipment.

Since its introduction into the telecommunications industry, ADSL has become a very popular service for the incumbents because it requires only the addition of new end equipment and not the replacement of cable, which is very expensive.

Another type of DSL being deployed is very high-speed digital subscriber line 2 (VDSL2) which can provide a sum of downstream and upstream speeds of up to 200Mbps. A drawback of the technology,

however, is that it requires customers be within three cable miles of the DSL equipment, and even that is no guarantee of service for several reasons.

In the city Verizon's DSL is limited to 15 Mbps.

CATV/ Coaxial Cable

The cable TV (CATV) provider Spectrum (formerly Time Warner Cable) utilize Data Over Cable Service Interface Specification (DOCSIS) over a hybrid fiber optic/coaxial cable network to provide high quality video, high speed data, and voice services to their customers.

In most cases, the fiber provides a connection from the signal origination, referred to as the headend, to a node which converts optical signals to electric. From the node, the signal is sent to the customer site via coaxial cable. The high-performance characteristic of coaxial cable supports the transmission of telephone, video, and data.

The CATV provider utilizes cable modem technology, which uses a single coaxial cable TV connection to a customer location to support the simultaneous transmission of voice, TV programing, and Internet. In the City broadband access is available in many areas via this hybrid fiber/coaxial infrastructure installed by the incumbent cable TV provider.

Dark Fiber

Dark fiber is the term used in the industry to describe fiber optic strands (in the cable) that are leased or sold to the customer or end user without services delivered over them. Unlike fiber from a service provider, the end user must light and operate the fiber strands with their own electronics.

This type of fiber is typically used to connect multiple locations together over an end user's private network. The advantage of dark fiber is that the end user has control over the type of technology and network used. However, the end user is also responsible for operation and maintenance of the infrastructure. Crown Castle is an example of a dark fiber provider.

3.2 Central Offices (CO's)

The Central Office is a building, typically made of brick or concrete block, that the incumbent telephone company uses to place and operate voice, data, and video switching equipment. The equipment used in the local Central Office determines the level and availability of services within a certain area or "wire boundary" which is the extent to which the wires leaving the CO can reach. Verizon has six central offices serving different areas in the city.

3.3 Utility Poles

Utility poles and telephone poles are generally owned by one of the following organizations: the local power companies, the incumbent telephone companies, or the municipal entities including villages and cities. Utility poles are used to carry electric power lines and telecommunications cables. The electrical power lines are generally located at the top of the pole and the telecommunication lines are attached on the sides.

To be compliant with the National Electric Safety Code (NESC) there must be 40" of separation between a telecommunication line and a power line on the pole. The area on the pole where the

telecommunication cable resides is known as the communications space or "comm space." Usually, aerially mounted fiber cable is tagged with an orange, blue, or yellow label so it is easily identified for maintenance or repair.

All poles have a limited number of telecommunications lines they can carry. These lines are attached on the pole one on top of the other. Therefore, a taller pole can accept more lines than a shorter one. Once lines are installed on a pole, adding a new line can require moving existing lines to make space for the new one.

In the construction process of adding a new cable, moving the existing lines, or replacing a pole to make room for another is called "Make Ready" work.

Most poles in the city are owned by the utility companies National Grid and Verizon. Others include Spectrum. However, many of the areas of Buffalo are served by a vast underground network of conduit including business and residential areas.

3.4 Water and Wireless Towers

Wireless technologies are the fastest growing segment of the telecommunications industry. Wireless infrastructure supports cell phones, pagers, personal digital assistants (PDAs), mobile data terminals, messaging, and Internet services. Wireless antennas or access points are located on wireless towers, tall buildings, and even water towers throughout the city. In some instances, the wireless infrastructure installed can offer connectivity in areas where landline services are cost prohibitive.

Wireless bandwidth technologies are developing at a rapid pace. Hybrid solutions that are using fiber as the backhaul and wireless as the "last mile" are being tested and installed across the country. Using fiber cable to get close to the customer, new and emerging wireless technologies are bridging the gap by providing high bandwidth service over the last mile costly link to the customer home.

These new hybrid systems can provide speeds of 50Mbps and more. Cellular companies and wireless Internet service providers (WISPs) are beefing up their networks in preparation for new wireless technologies that will allow them to connect to customers in residential environments.

The key to wireless providers accessing residential areas is the availability of fiber infrastructure and vertical assets where the provider can place their antennas. Even the incumbent telephone companies are beginning to take notice. AT&T is now using wireless technologies to bring high bandwidth to homes.

Their Fixed Wireless Internet promises to bring speeds in excess of 10Mbps down and 1Mbps up. However, based on the current FCC definition of broadband access, which is 25Mbps downstream and 3Mbps upstream, this would not be considered ideal.

Cellular Technology and Towers

Many of the wireless towers in the city have cellular equipment installed on them to provide cell phone-based coverage. The service coverage of a typical cellular equipped tower can be anywhere from one to ten miles, depending on the equipment in use, how the equipment is set up, terrain, and the height of the towers.

Cellular service is limited in bandwidth and is typically charged on a "data cap" rate. This pricing limits the data used per month - which equates to very expensive data plans for Internet usage. Because of these two factors, it is generally not considered a viable small business and home form of Internet access at this time.

There are 51 wireless tower structures identified either through field inspection, GIS database research, registered with the FCC data base or through data provided by the city. Many of the towers are located in the northern half of the city in the North, Delaware, Masten and University districts.

The height of the registered towers range of 22 to 226 meters with the majority being in the 30 to 80 - meter range. Owners of the wireless towers in the city are shown in Table 3.

Wireless Towers in Buffalo, NY	
Owner Name	Towers
American Towers, LLC	14
Bell Atlantic Mobile Systems of Allentown, Inc	1
City of Buffalo	1
City of Buffalo, Fire Communications	1
County of Erie	1
Crown Castle International	10
Dogwood Towers	2
Eco-Site, LLC	1
Erie County Central Police Services	1
MAIN SENECA CORP DBA = RAND BUILDING	1
Nexstar Media Inc.	2
NIAGARA MOHAWK POWER CORP	1
SBA Communications	2
SBA Towers II LLC	1
SBA Towers, LLC	1
SBC TOWER HOLDINGS LLC	2
SectorSite, LLC	1
SHERIDAN BROADCASTING CORPORATION	1
Spectrum Northeast, LLC	1
Uniti Towers LLC	1
Up State Tower Co., L.L.C.	1
US ARMY CORPS OF ENGINEERS	1
VB Nimbus, LLC	3

TABLE 3 VERTICAL ASSETS REGISTERED WITH THE FCC IN BUFFALO, NY

Tower locations are important to Wireless Internet Service Providers (WISPs) and others as they highlight availability of vertical assets that could support the installation of access point equipment.

A map showing the locations of wireless towers in the city appears in Figure 5 on the following page. Fiber optic transport is important as a high bandwidth backhaul to wireless last mile services.
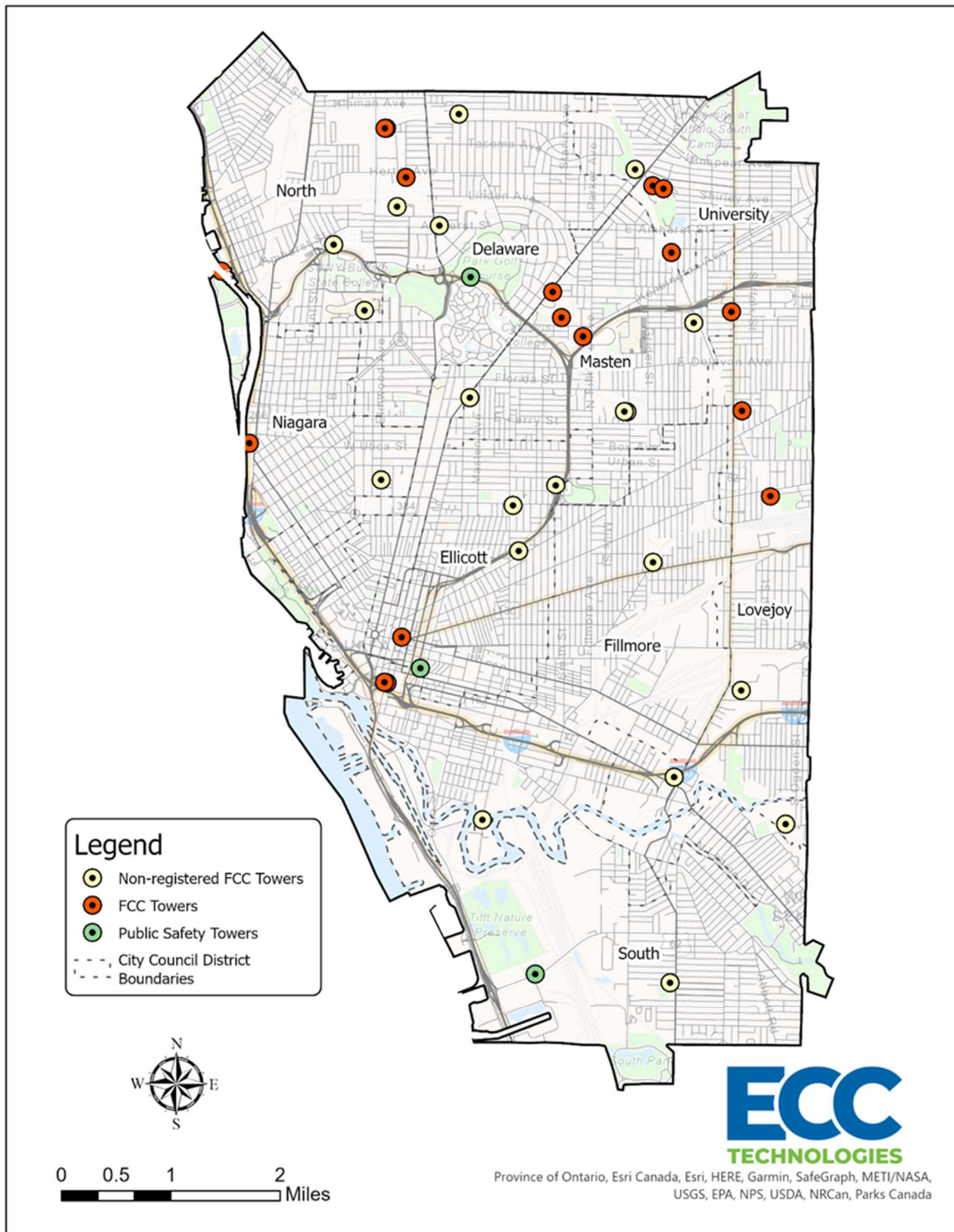
FIGURE 5 CITY OF BUFFALO TOWERS

4. Telecommunications Inventory

This section of the report is an inventory of the telecommunications service providers and their supporting landline and wireless infrastructure in the City of Buffalo The data collected includes all the relevant service providers including the incumbent service providers, the competitive service providers, the wide area network providers, and others.

Additional information is included on specific provider infrastructure including fiber, coaxial cable, wireline boundaries, Central Office locations, and wireless towers.

4.1 Telecommunications Service Providers

Voice, video, and data services are provided to the city residents and businesses by a variety of companies using a range of technologies and infrastructures. As previously discussed, services can be provided over copper wire, coaxial cable, fiber optic cable, wireless technologies, and via satellite.

The incumbent telephone companies, or ILECs (incumbent local exchange carrier) and the incumbent cable TV providers are the primary owners of telecommunications infrastructure within the city. There are also a few CLECs (Competitive Local Exchange Carriers), two fixed wireless Internet providers, three satellite providers, and several cellular companies.

Each of these providers uses different methods of delivering services to their customers, resulting in varying speeds and reliability. Typically, fiber and coaxial cable provide the fastest, most reliable speeds, while copper wire, fixed wireless, and satellite provide the lowest and least reliable.

Copper wire is an older technology with limitations inherent to its structure; wireless speed and reliability is dependent on distance from the infrastructure and clear line of site; and satellite can be compromised by weather or obstacles like tall buildings and foliage. These factors are important to bear in mind when determining whether businesses and residents truly have adequate access to effective Internet services.

4.2 ILECS, CLECS, and Region Wide Area Networks

A local telephone company or incumbent local exchange carrier (ILEC) is responsible for development and maintenance of the cabling and switching equipment needed to deliver local telephone and other telecom related services to the communities. The ILEC providing service within the city is Verizon.

A map showing Verizon's central office locations and identified fiber routing in the city is shown in Figure 6. Central Offices, or COs as they are better known, are typically structurally robust buildings that house the telephone company switching and local network equipment.

As with all the outside plant (OSP) field generated maps, careful consideration should be given before this map is copied or distributed.
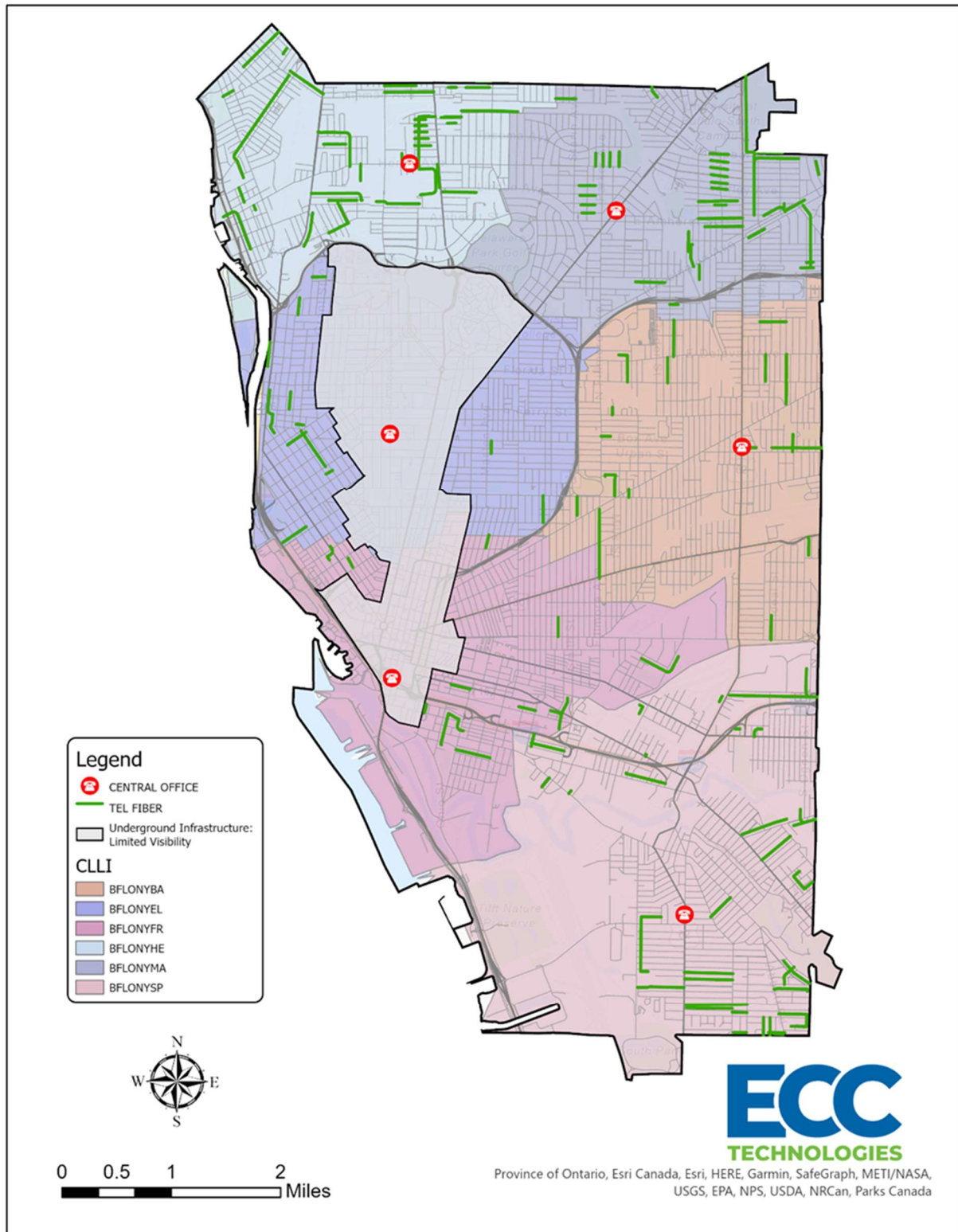
FIGURE 6 ILEC MAP WITH TEL FIBER, CO'S, AND WIRE BOUNDARIES

Verizon.

Verizon's corporate headquarters is in New York City, they have offices in Buffalo with a regional business office located in Syracuse. Verizon offers voice, data services, DSL, cloud services and managed network services to the businesses and residents in their area of the City.

The Verizon territory covers the entire City area. They offer services from their 6 Central Offices (CO's). According to their FCC report, Verizon offers DSL services of up to 15 Mbps in most areas and faster speeds in the areas listed below where they offer fiber to the home. Lastly, Verizon is providing limited copper-based services under the MCI name according to its 477 filing.

Table 4 describes the telecommunications services currently available at each of Verizon's Central Offices. These services are supported by the switch technology at the location of the Central Office and may or may not be available to a customer within the exchange.

The service is dependent upon the cabling infrastructure available and the distance from the serving Central Office. The service information is based on the provider's 477 reporting as of June 2020.

Central Office	Copper	Fiber
Verizon	DSL	FTTH
BFLONYHE (935 Hertel Ave)	15 Mbps	Up to 1 Gbps
BFLONYMA (2743 Main St)	15 Mbps	Up to 1 Gbps
BFLONYEL (548 Elmwood Ave)	15 Mbps	n/a
BFLONYDA (715 Delaware Ave)	15 Mbps	n/a
BFLONYFR (65 Franklin St)	15 Mbps	n/a
BFLONYSP (1861 S Park Ave)	15 Mbps	Up to 1 Gbps

TABLE 4 CENTRAL OFFICE AND SERVICES IN BUFFALO, NY

Telephone Company Fiber Routes and Fiber to the Home Areas

Based on 477 info Verizon and Spectrum have fiber to the home offerings in the city, Figure 7 illustrates the fiber to the home installs identified in several areas of the city. The Fiber to the Home areas are primarily in the northern districts including University, Delaware and North and the South district. Spectrum has FTTH in only 5 census blocks in the city which are in Niagara and Masten Districts. For these areas, fiber based last mile infrastructure allows for any future level bandwidth service the end user might require.
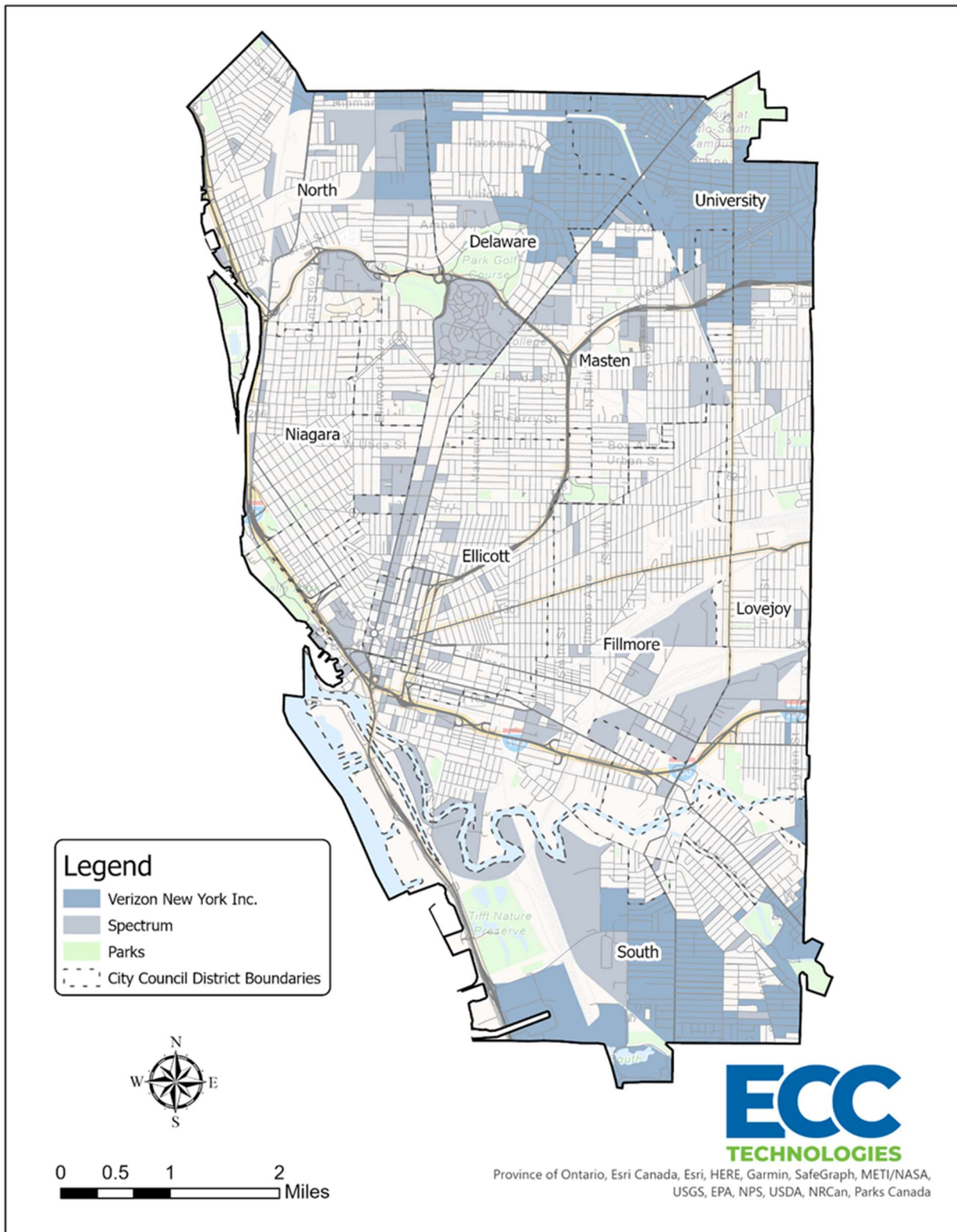
FIGURE 7 TELEPHONE AND CATV FTTH AREAS IN BUFFALO, NY

4.3 Competitive Local Exchange Carriers (CLECs).

CLECs are telephone companies created to compete with the Incumbent Local Exchange Carriers (ILECs). CLECs arose as a result of the Telecommunication Act of 1996, which was intended to promote competition among long distance and local phone service providers. The term is used to differentiate between new or potential competitors and established local exchange carriers. ECC identified eight CLEC companies with facilities in Buffalo NY. These CLECs include Cogent, Crown Castle, FirstLight, CenturyLink (Level 3), Verizon Communications (MCI, and XO Communications), Windstream (also providing service under the names Earthlink, Paetec and US LEC) and Zayo. Information on the number of census blocks served by provider can be found at the end of this section.

A CLEC that provides regional wide area network services is a company that either owns or leases fiber infrastructure in each area to connect customers to provide customer point to point internal communications or Internet access.

These companies typically target customers such as school districts or healthcare organizations that have multiple locations in a spread-out area. This type of provider can also provide access to another service provider, which is referred to as middle mile access or wholesale backhaul.

Type of Org.	Business Only	Provider Name
CLEC	x	Cogent Communications
CLEC	x	Crown Castle Fiber LLC
CLEC	x	FirstLight Fiber
CLEC	x	Level 3 (CenturyLink)
CLEC	x	MCI (Verizon)
CLEC	x	Windstream (Also Earthlink, Paetec and US LEC)
CLEC	x	XO Communications Services, LLC
CLEC	x	Zayo Group, LLC

TABLE 5 CLEC'S PROVIDING BUSINESS SERVICES IN BUFFALO, NY

Crown Castle and FirstLight have significant fiber cable in the city and are further discussed in the regional provider section below. Discussed below is information on some of the larger CLEC based providers in the area.

CenturyLink/Level 3.

CenturyLink, a national ILEC and CLEC purchased carrier Level 3 a number of years ago. Their presence in City is limited to other copper-based services just as T1s and fiber-based services. According to their 477 filing, CenturyLink has fiber-based business customers 75 census blocks.

Windstream (Earthlink/Paetec/US LEC).

Windstream Communications' headquarters is in Little Rock, Arkansas and has a business location in Fulton, NY. Windstream is a national incumbent telephone company that provides competitive service (CLEC) in some marketplaces. In the past decade they have purchase other national CLECs including

EarthLink, Paetec and US LEC. They also provide a wireless service under the name Business Only Broadband.

According to their FCC 477 filing report, Windstream provides copper-based DSL and fiber service to several business customers. They provide service in a 143 census blocks in the city.

Other Fiber Owners

In addition to the typical service provider fiber other owners of fiber cable were identify during the OSP field study, these included the University of Buffalo and NYS Department of Transportation. Generally, this type of fiber is not available for third party use.

The map below represents the Competitive Local Exchange Carriers' fiber routes identified in the city during the field study and the service areas based on the 477 information, which will give an indication of where they have customers in the city. It should be noted that Crown Castle purchased Light Tower.

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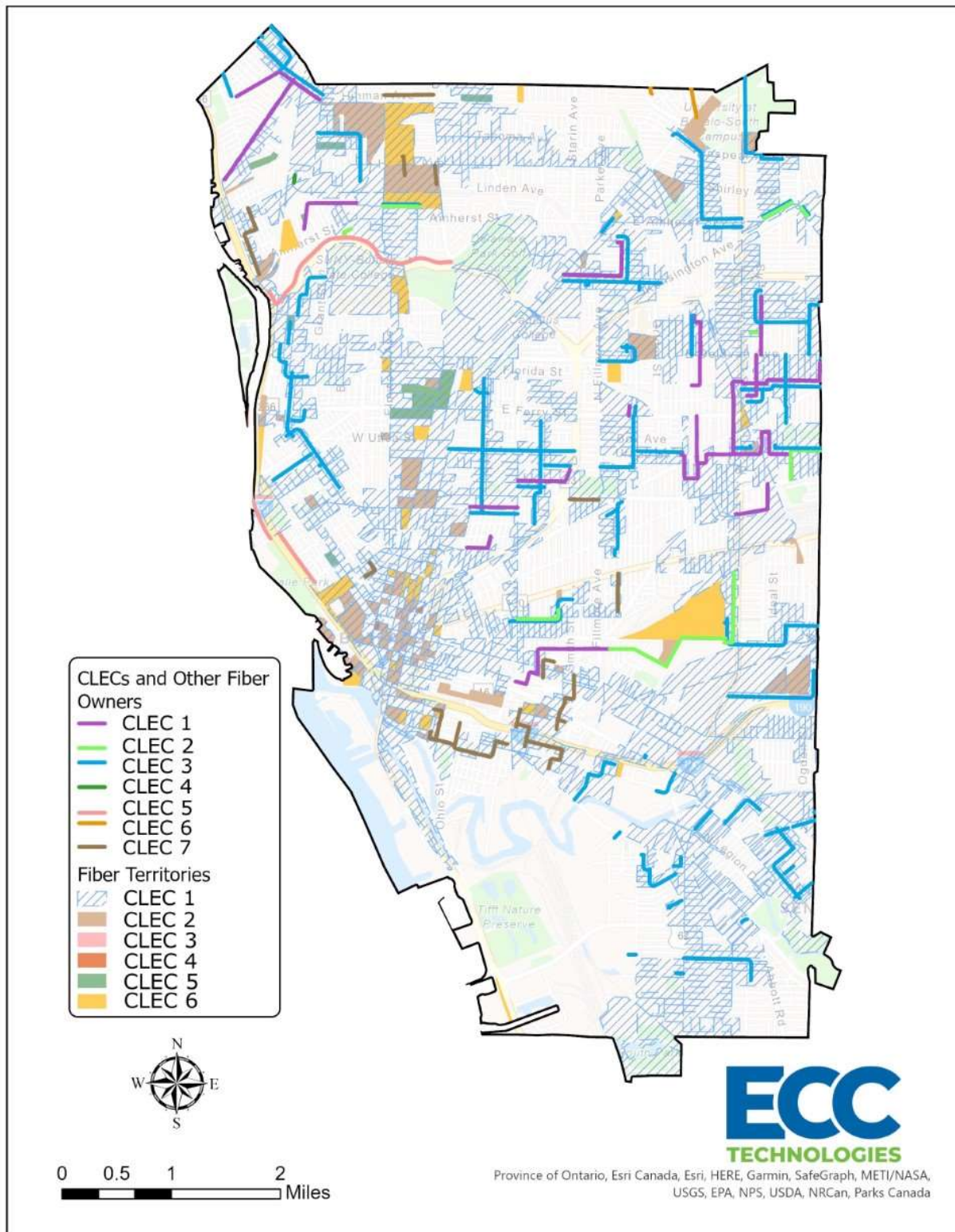
FIGURE 8 CLEC AND OTHER FIBER MAP IN BUFFALO, NY

4.4 Cable TV Provider

Cable providers, like all service providers, will typically build and provide new service where they deem it profitable. Should a company or residential customer purchase a service in an outlying area, and is willing to pay for the installation, the cable provider will expand access, providing service along that new route to businesses and residents. Cable providers offer their service via fiber optic or coaxial cable. Spectrum Communications is the only cable TV provider identified in the city.

Spectrum Communications

Spectrum Communications provides competitive services to the incumbent's DSL service in areas that it has fiber and coaxial cable infrastructure. Spectrum operates a hybrid fiber/coaxial-based network system in the city, which gives them the capability to provide dedicated business-based fiber services of ethernet, voice, video, managed services, and high bandwidth residential service over coaxial cable.

According to their FCC filing, Spectrum provides residential triple play services of voice, Internet, and cable TV. Internet only prices starting at $29.99 in the area. Speeds of 940Mbps down and 35 Mbps up are offered to both residential and business customers. Business service packages start at 200Mps and include business voice services with no contracts.

Figure 9 on the following page show Spectrum's fiber optic and coaxial infrastructure documented on the high level OSP study work and the reported 940 Mbps service area. Both fiber and coax can be used to provide broadband service.

As with all the outside plant (OSP) field generated maps, this map is considered highly confidential information and should not be copied or distributed.

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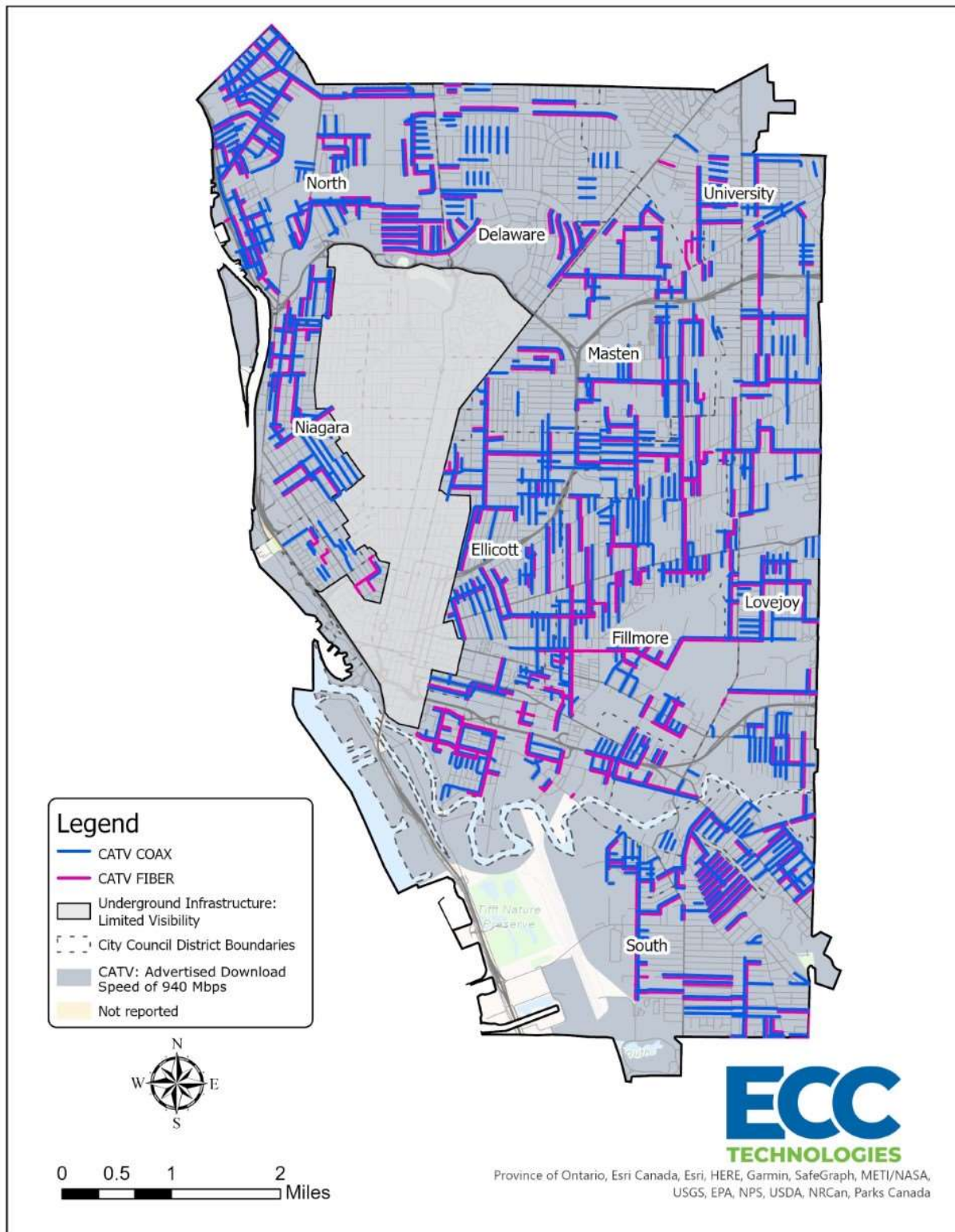
FIGURE 9 INVENTORY OF CATV COAX AND FIBER

4.5 Other FTTH Provider

Greenlight Networks

Greenlight Network is a fiber to the home provider based in Rochester, NY. According to their website Greenlight was founded in 2011, in Penfield, NY. They are the first provider in that area to offer gigabit speeds to customers. Greenlight provides service to both residential and business customers. According to their website pricing for their 500 Mbps starts at $50 per month. They are currently targeting areas in Buffalo, Binghamton, and Rochester to expand their territory.

The map below taken from the providers website shows the area of the city they are evaluating or constructing fiber to the home. As can be seen in the legend they have areas that are currently under construction, construction that will happen in 2021 and pre-construction. At this time, it does not appear they have any area in Buffalo that they are providing service today.
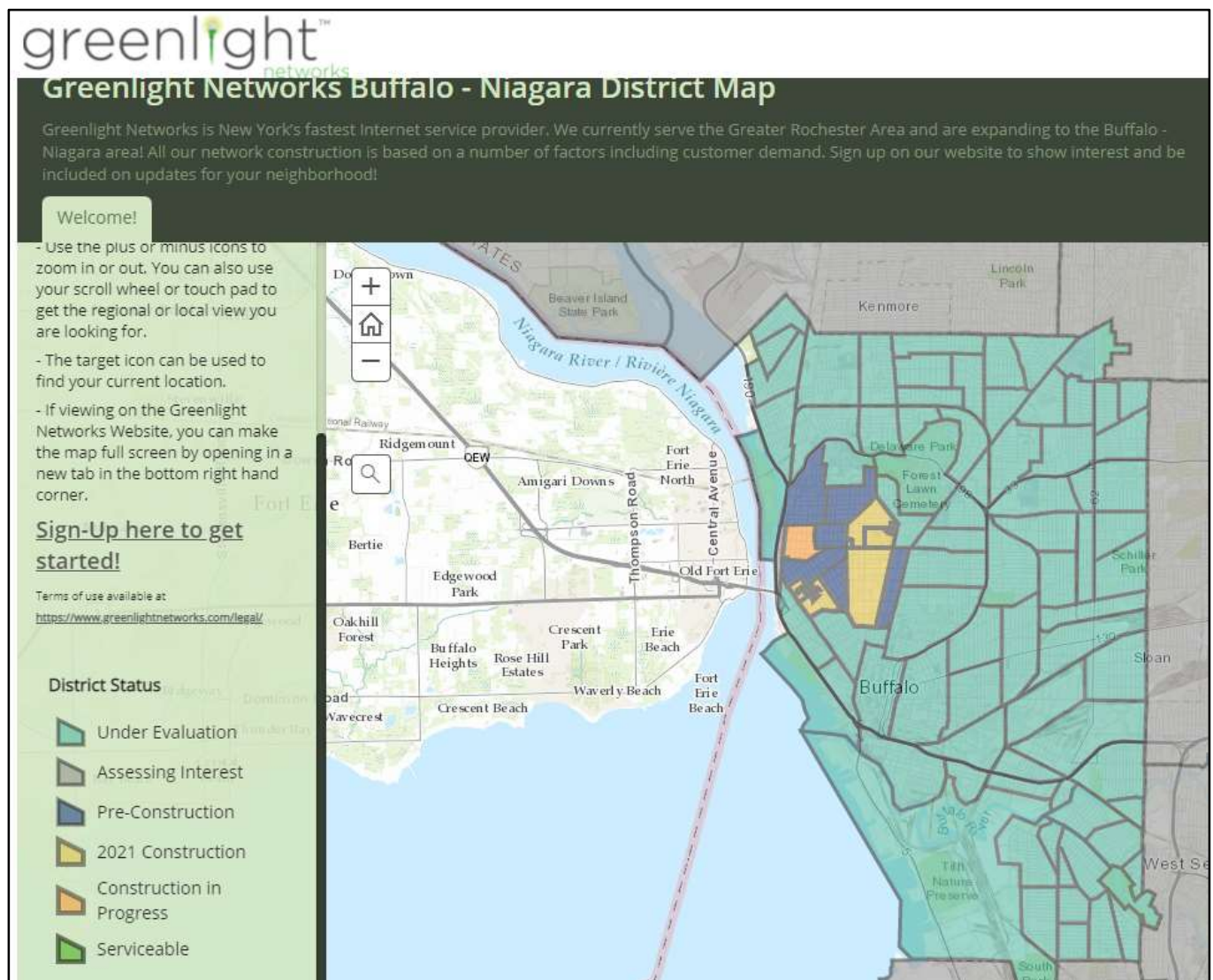
FIGURE 10 GREENLIGHT NETWORKS IN BUFFALO

4.6 Wireless Internet Service Providers (WISPS).

Business Only Broadband

Previously documented in the CLEC section of this report, Business Only Broadband or BOB LLC. is a wireless based subsidiary of Windstream. They provide fixed wireless Internet service to customers in major cities across the country.

BOB provides metro Ethernet data network and Internet services to the financial, healthcare, education, government, hospitality, and other enterprise sectors. According to their 477-form submission, they provide service in 12 census blocks.

Transwave

Transwave Communications Systems Inc. is the only other fixed wireless provider identified in this study. Located in Clarence, NY, Transwave provides wireless point to point service to carriers and government healthcare, industry, education, and others. According to their 477 reporting they are providing service in 48 census blocks. Bandwidth and pricing for their service is based individual case basis.

On the next page is a map that shows the 477 based coverage for both WISPs identified.

[The remainder of this page is intentionally blank.]
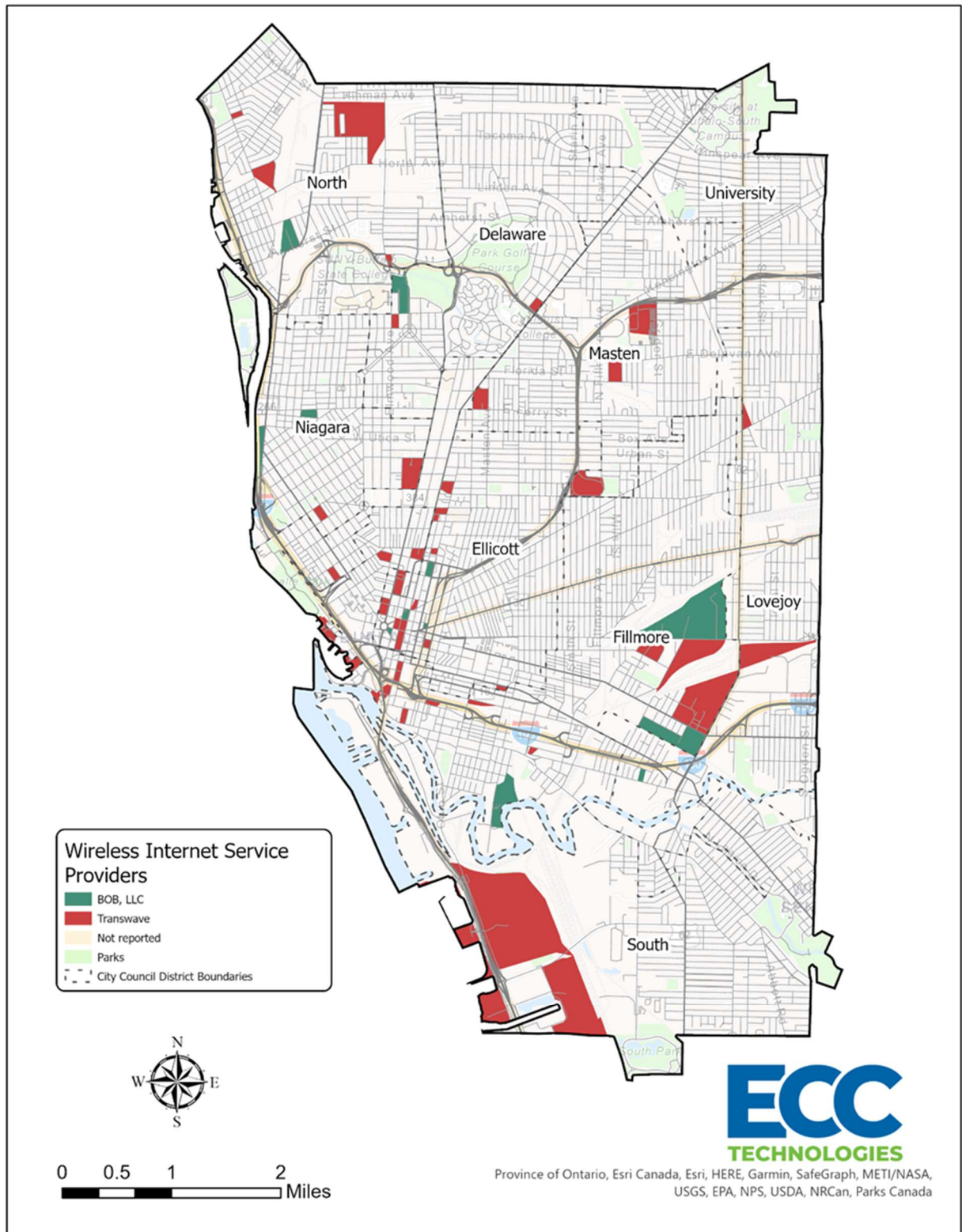
FIGURE 11 WISP's IN BUFFALO

Providers listed by Type of Service and Number of Census Blocks Served

Table 9 below lists all the land line and fixed wireless providers that reported service, and the type of service by number of census blocks to the FCC in June 2020. For reference purposes there are 3,303 census blocks in the city.

		477 Types of Reported Services by No. of Census Blocks (subject to rounding by FCC)							
Type of Org.	Business Only	Provider Name	10 - DSL	11 - DSL	12 - DSL	30 - other copper	43 - Coax	50 - Fiber	70 - Fixed Wireless
WISP	x	Business Only Broadband							12
CATV		Spectrum (Charter Com)					3,230	159	
FTTH		Chautauqua & Erie Tel Corp		4	2			2	
CLEC	x	Cogent Communications						2	
CLEC	x	Crown Castle Fiber LLC						1,408	
FTTH		DFT Local Service Corp						3	
CLEC	x	FirstLight Fiber						15	
CLEC	x	Level 3 (CenturyLink)				29		75	
CLEC	x	MCI (Verizon)				55			
WISP		Transwave							48
ILEC		Verizon New York Inc.	2,910					465	
CLEC	x	Windstream New York, Inc. (Also Earthlink, Paetec and US LEC)	45	57	1	3		46	
CLEC	x	XO Communications Services, LLC				19			
CLEC	x	Zayo Group, LLC						2	

TABLE 6 REPORTED SERVICES BY CENSUS BLOCKS - FROM FCC 477 DATA

4.7 Satellite

Satellite providers use geostationary satellites orbiting the Earth at the same speed of the Earth's rotation, allowing them for all intents and purposes to maintain "fixed" position, to transmit signals from the Network Operations Center (NOC) to a satellite dish mounted at a business or residence.

According to their 477 reports, two satellite providers claim one hundred percent residential coverage to the city. HughesNet advertises speeds of 25Mbps by 3Mbps. Viasat lists speeds of up to 30 Mbps. As with all satellite providers, one of the greatest issues with service is latency, which is typically 0.5 seconds in length. This can prove problematic with VPN connections or when users are engaging in time sensitive activities, such as live online gaming.

According to FCC 477 filing GCI, another satellite-based provider is offering business / commercial internet.

Current NY Broadband Program funding will enable HughesNet to deploy its new Gen5 satellite broadband service offering download speeds of at least 25 Mbps to the awarded Census Blocks. The grant-supported service area will offer a monthly rate not to exceed $60 with an installation fee not to exceed $49.

These rates are lower than the providers current price offerings. The HughesNet service plan has a monthly usage allowance. Exceeding the monthly allowance can result in slower service. But the service will not have additional charges.

In the New NY Broadband program, HughesNet has committed to the state to use its best efforts to deliver download speeds of 3 Mbps when a user's data plan has been exceeded, but with no guarantees. Table 7 shows the New NY Broadband grant to HughesNet and total investment. Also shown are the number of locations to be served by village of township.

New NY Grant Awards to HughesNet by Area			
Location	State Grant	Total Investment	Locations Addressed
Buffalo	$107,100	$161,795	664
Village of Blasdell	$315	$450	2
Total	$107,415	$162,245	666

TABLE 7 NEW NY GRANT AWARD TO HUGHESNET

4.8 Cellular Service Providers

Cellular providers use radio frequencies to complete phone calls, send text messages, and transmit data from the nearest cell tower to the phone in use. Antennas on the towers both transmit and receive signals from mobile phones.

Cellular signals can be impacted by distance of the phone from the tower, building wall thickness, hills, or other structures. Clear line-of-sight is not necessary for cellular service to work but will increase call clarity and data transmission speed.

Standard 4G LTE cellular broadband networks can deliver peak download speeds of up to 100 Mbps. The successor to 4G LTE is 5G or 5th generation cellular broadband. Standard 5G service uses a low band spectrum that allows 5G to run simultaneously with 4G LTE service providing speeds of between 30 and 250 Mbps. 5G Ultra-Wideband is a type of 5G technology that uses the high-band, ultra-wide millimeter wave spectrum to deliver download speeds in the 1 Gbps range.

There are three national cellular service providers with coverage in the City of Buffalo with varying connection speeds. The providers' website coverage maps for AT&T Wireless, T-Mobile, and Verizon Wireless show they provide 5G and 4G LTE coverage. US Cellular is using a partner's network to provide coverage.

In addition to these traditional providers, Spectrum Mobile is a new cellular provider that uses Verizon's towers and relies on a network of Wi-Fi hotspots to keep costs low. However, to qualify for Spectrum Mobile the customer must have Spectrum internet service. US Cellular offers data and voice coverage in the City of Buffalo through a national partner and is therefore considered in the marketplace as a reseller but not as a facilities-based provider.

Each respective provider's website shows 4G and 5G service coverage in the city of Buffalo. AT&T has complete 5G and 4G coverage. T-Mobile has 5G Ultra and 5G Extended throughout the city with spotty 4G LTE coverage south of the city. Verizon has 5G Nationwide coverage throughout the city. Lastly US Cellular has partnership coverage all through the city.

AT&T.

Figure 12 below shows the areas of coverage available by AT&T. This information was obtained directly from AT&T's website.
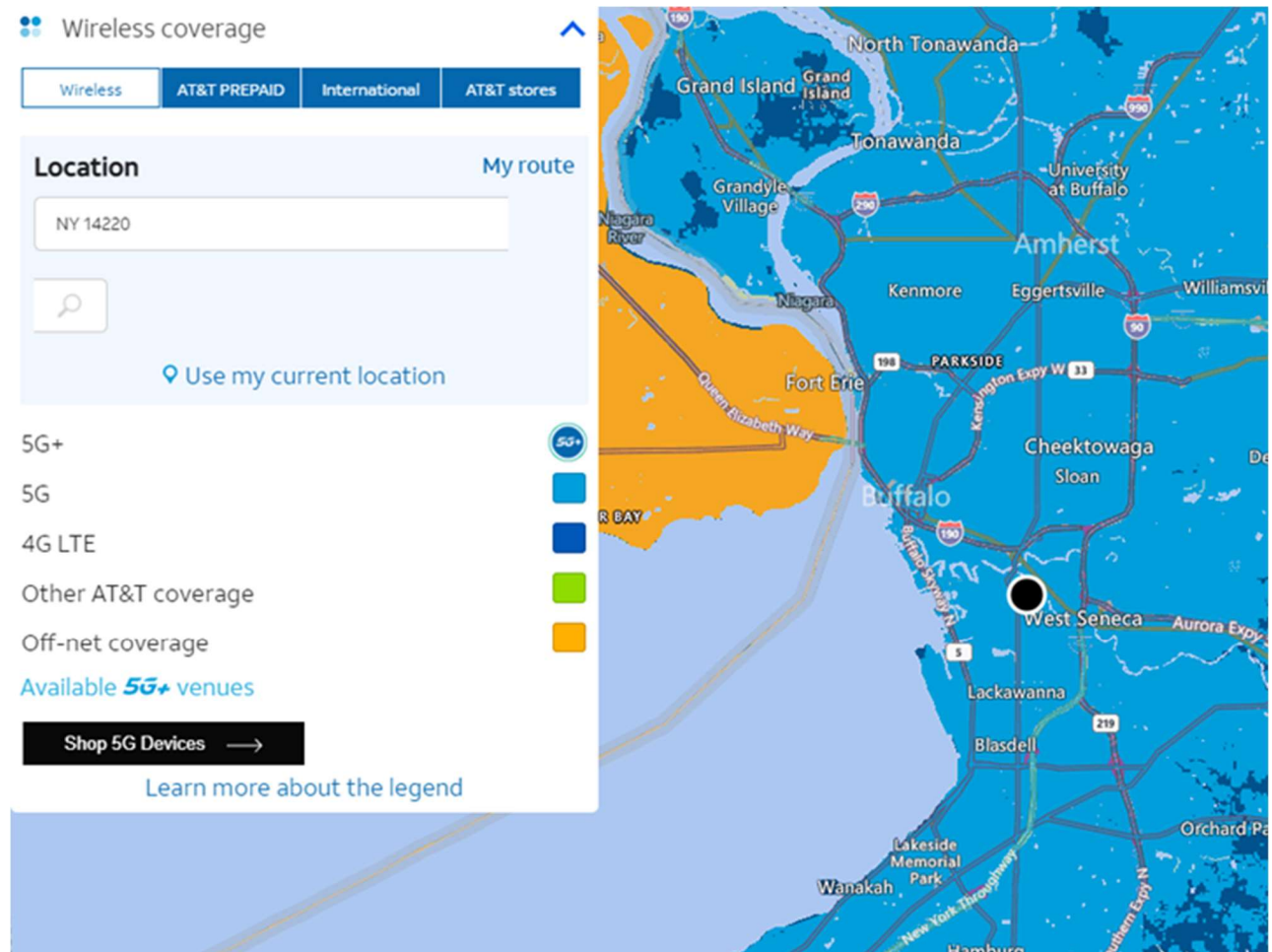
FIGURE 12 AT&T 5G AND 5G+ COVERAGE MAP

T-Mobile.

Figure 13 below, from T-Mobile's website shows the various coverage areas within the city.
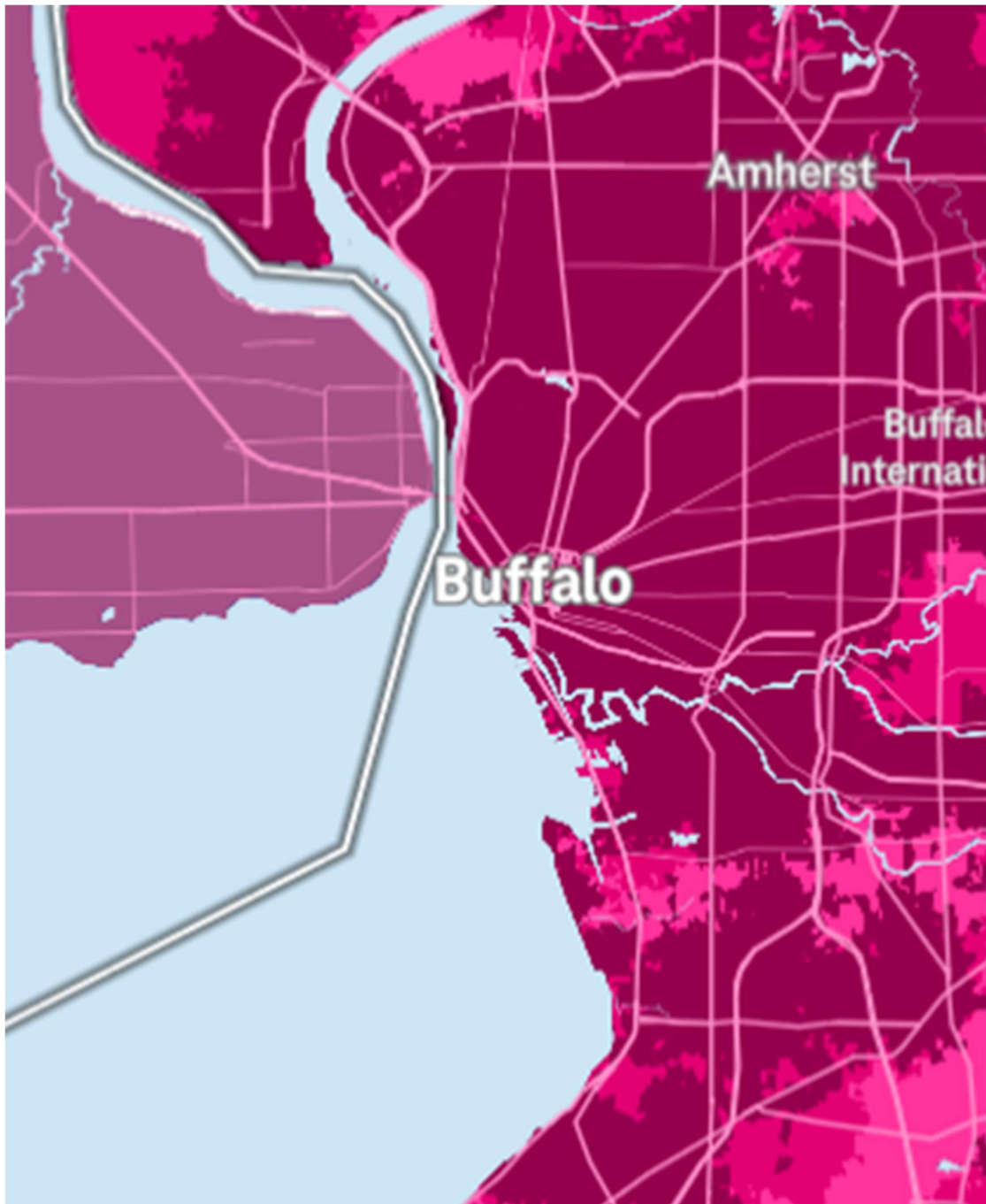
FIGURE 13 T-MOBILE 4G AND 5G COVERAGE MAP

Verizon Wireless

Figure 14 is from Verizon Wireless website showing 5G coverage in the city.

Legend
- **5G Ultra Wideband** — Available in parts of these cities
- **5G Nationwide** — Includes 4G LTE coverage
- **4G LTE**
- **3G**
- **International**
- **No Coverage**

5G Edge cities for business [Off]
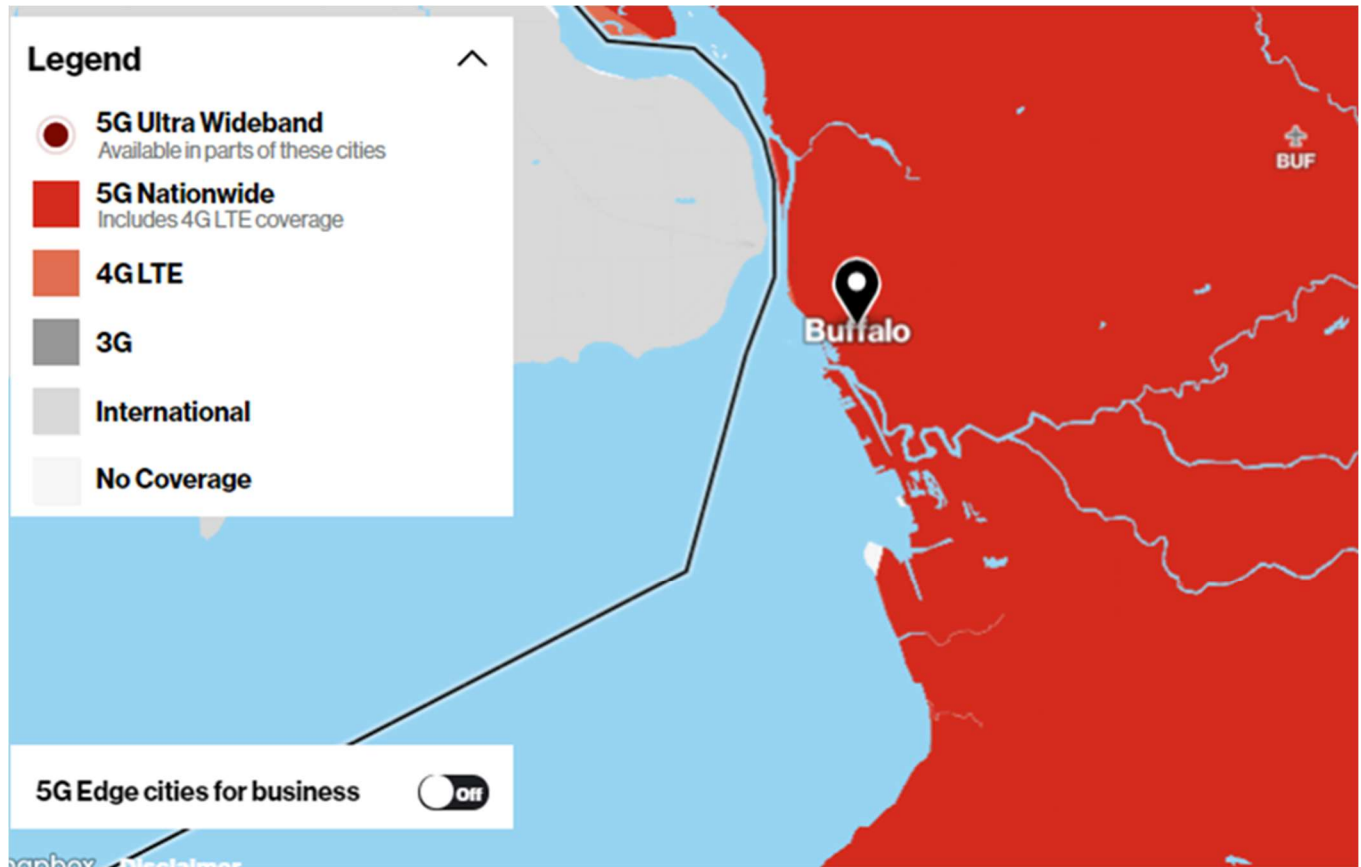
FIGURE 14 VERIZON WIRELESS 5G COVERAGE MAP

4.9 Regional Wide Area Networks

Crown Castle

Crown Castle Inc. (CCI) is a national company providing bandwidth to a customer base of wireless/cellular and wireline carriers, and in some target areas large enterprise customers. CCI does not provide service to residential customers.

Crown Castle has been buying fiber-based services companies over the past five years. Acquiring companies such as Fibertech, and Lightower. Along with the infrastructure, Crown Castle owns a significant amount of fiber as shown on the map below. Their primary customer are national cell service providers, and they are considering options to expand to support widespread competitive access to local businesses.

CCI have fiber throughout the western NY area with a concentration in the city of Buffalo. In addition, they have number of colocation sites and data centers in the city. According to their FCC 477 filing they provide service in 1,408 census blocks within the city.
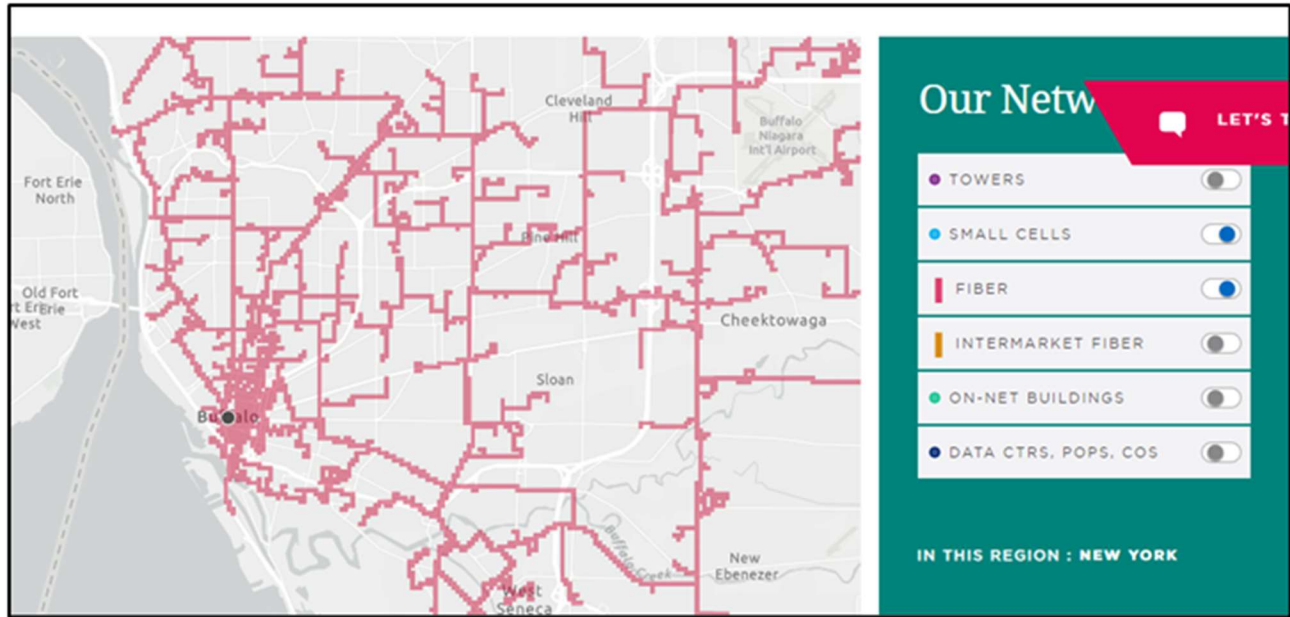
FIGURE 15 CROWN CASTLE FIBER MAP

FirstLight

FirstLight is a fiber-based service provider of Internet, data center, cloud and voice services to enterprise and carrier customers in New York, New Hampshire, Vermont, Massachusetts, and Maine over the Company's own fiber optic network. Over the past years they have made acquisitions, such as Oxford Networks, Sovernet Communications, Finger Lakes Technologies Group, 186 Communications and Todd Cable, a local fiber optic construction company.

According to their website, FirstLight has fiber routing through the western NY region as shown in the map on Figure 16 on the next page. They provide services to small and large businesses as well government, public safety, healthcare, education, and carriers/service providers. To date they do not provide residential services. Their offerings include Dedicated Internet Access, Ethernet, Cloud Services, and dark fiber. According to their FCC 477 filing they support customers in the city over 15 census blocks.

FIGURE 16 FIRSTLIGHT FIBER MAP

4.10 Broadband Availability & Service Gaps

Broadband providers must submit data to the FCC twice per year on broadband deployments. Form 477 is the FCC nomenclature which establishes the format of the data submitted. This FCC data is only granular to the census block level; meaning that if one household within a block is served by that provider, the whole block is reported as being served.

Throughput on Form 477 is reported within speed tiers/ranges and reflects the maximum advertised download and upload speeds within that block, by that provider. Said differently, the information by its very nature is overstated by the providers.

This data provides an accurate though dated foundation of general broadband availability in a City and can be utilized as a planning tool by capturing which providers are active in which areas or census blocks. However, the Form 477 data does not capture the exact service available to each home within a block.

Figures 17 is map created by ECC using the publicly available FCC Form 477 datasets. The different colors represent various ILEC speeds of service, ranging from no service up to 1 Gigabit per second. The different colors designate the different speeds offered according to their website. This information will be used to make comparisons to the field inventory study.

In Figure 18 on page 48, ECC overlaid the CATV fiber and coaxial data layer onto the FCC served census blocks data. Spectrum reports that they provide 940 Mbps downstream in all of their service areas in the city of Buffalo.

The Form 477 information is at least 18 months old and any new network expansions in the city are "turned up," not necessarily represented. The FCC data is often inconsistent with data from private reporting sources and sometimes, even the providers websites.

Figure 19 on page 49 shows the fiber optic cable and coax cable discovered and documented in the city field survey with the census block housing density displayed.

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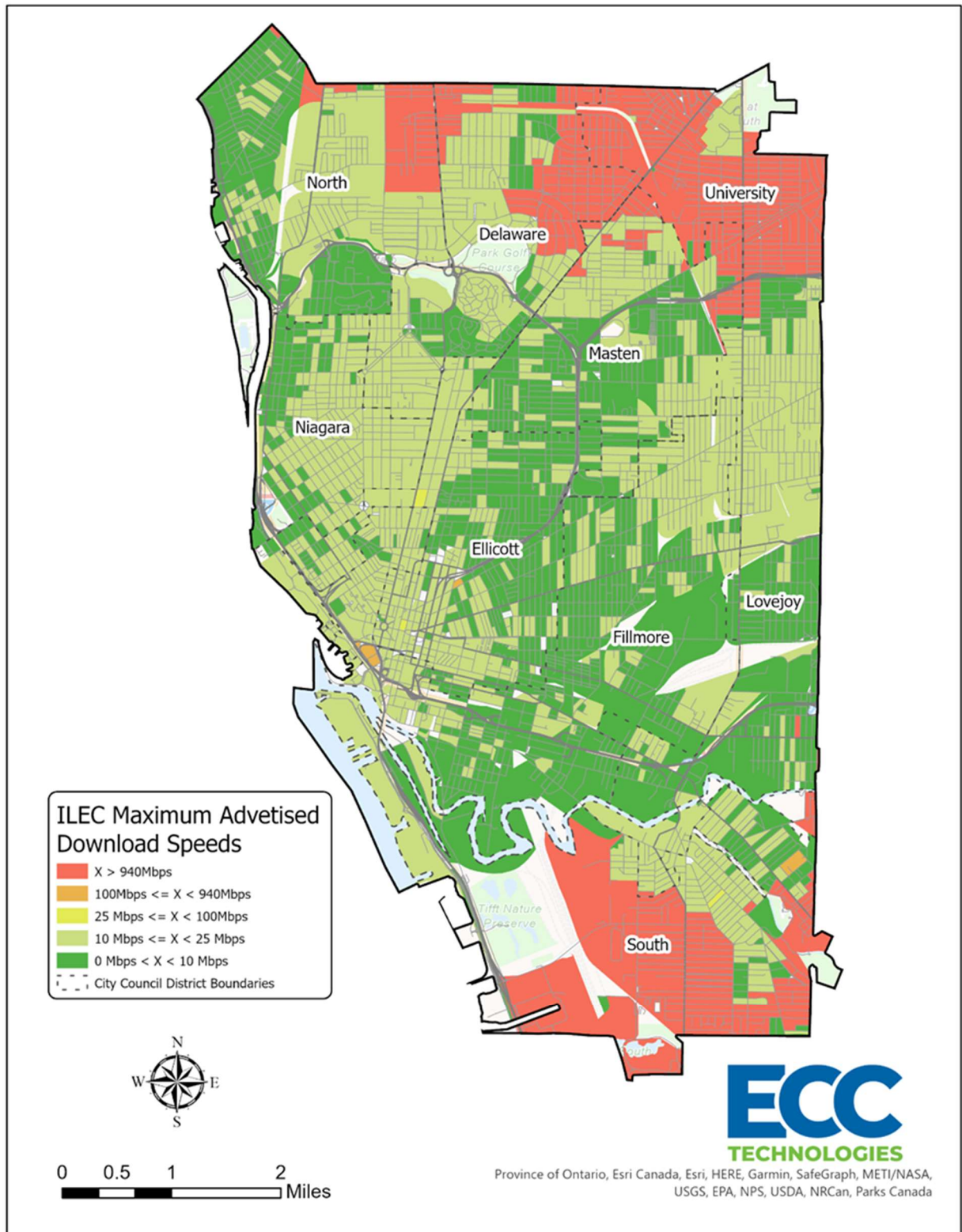
FIGURE 17 FCC 477 DATA - ILEC MAXIMUM ADVERTISED DOWNLOAD SPEED
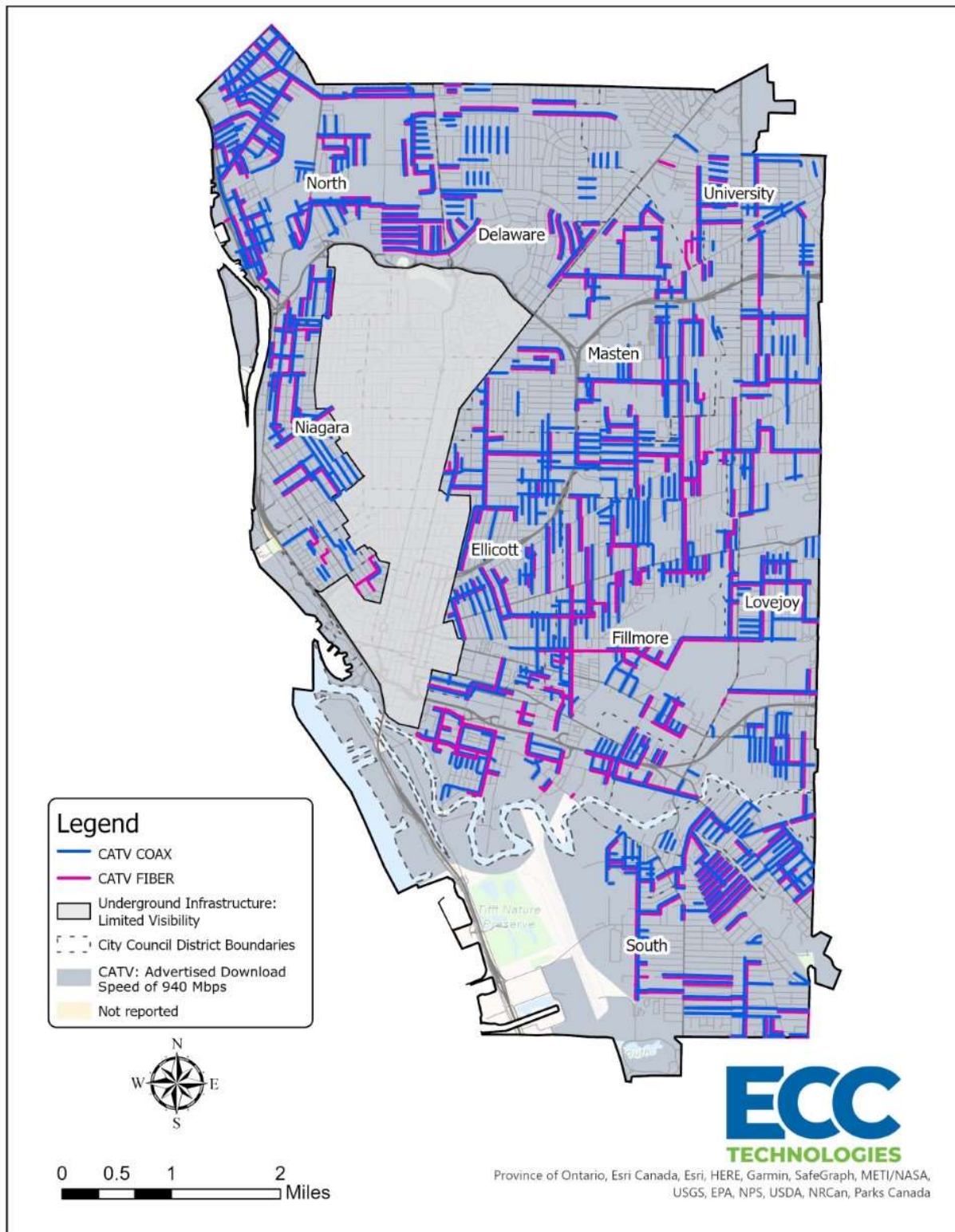
FIGURE 18 FCC 477 DATA CATV MAXIMUM ADVERTISED DOWNLOAD SPEEDS
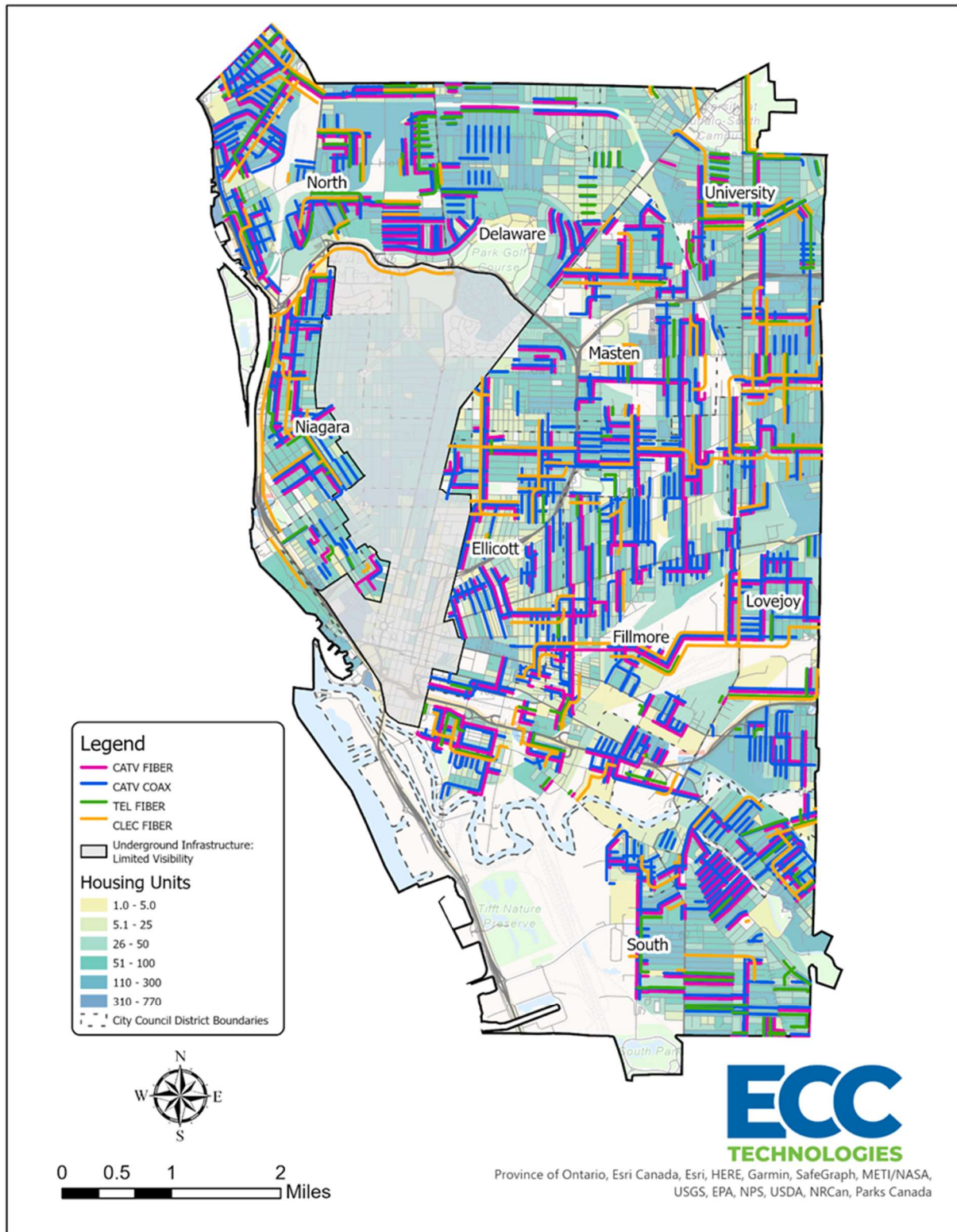
FIGURE 19 INFRASTRUCTURE OVER CENSUS BLOCKS WITH HOUSING DENSITY

4.11 Broadband Providers and Speeds by Town and Zip Code

The following pages list internet providers, type of service offered, coverage area and the maximum speed advertised for City by zip code. This information was gathered by keying in zip codes from an online database that utilizes the FCC 477 information.
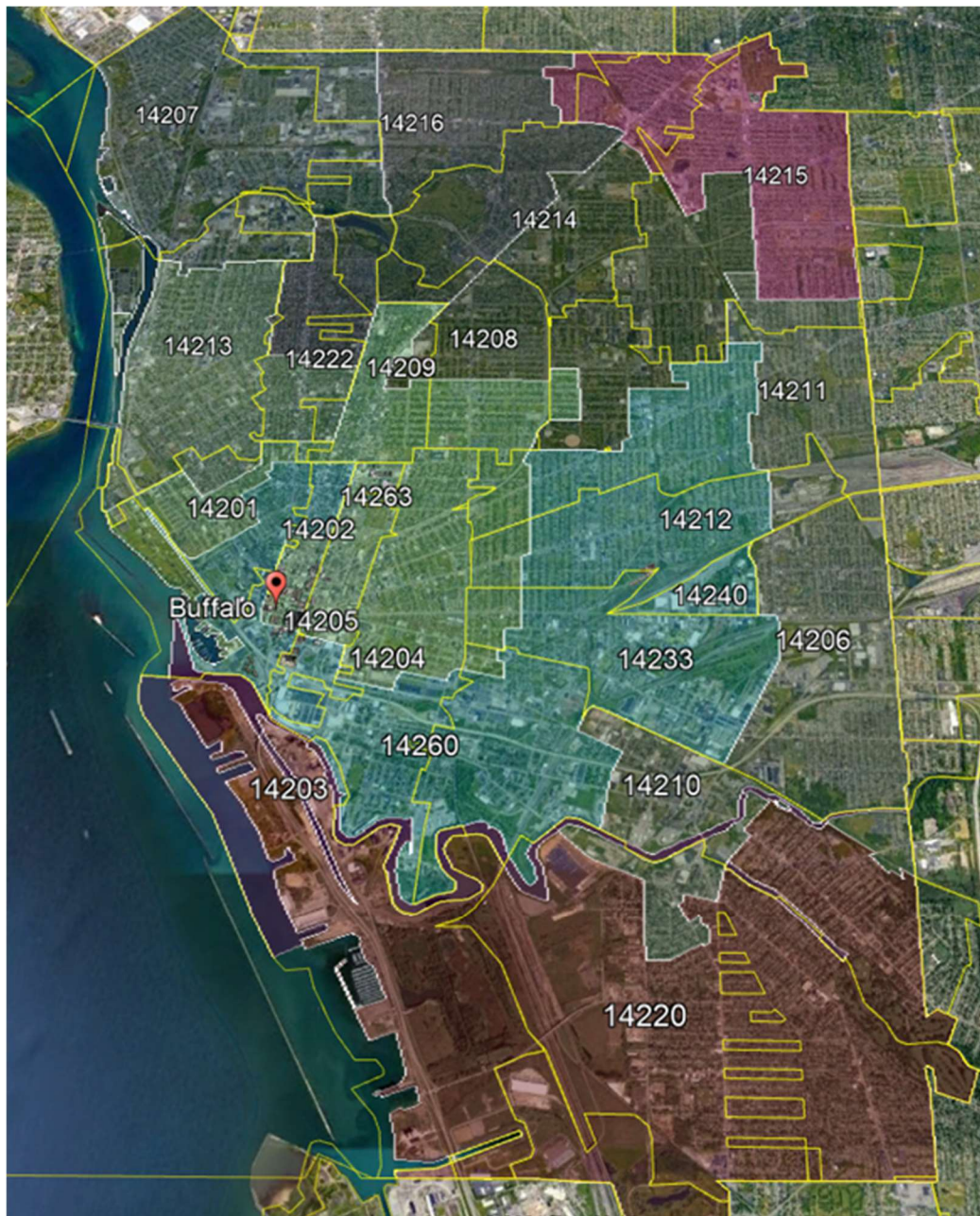
FIGURE 20 CITY ZIP CODE MAP

Figure 20 City Zip Code Map is shown above for illustrative purposes and can be used as a key to assist with identifying provider service.

The following table list the Internet Service Providers by Zip Code. The term Internet service provider (ISP) refers to a company that provides access to the Internet to both personal and business customers. ISPs provide the ability to surf the web, shop online, conduct business, and connect with family and friends. ISPs may also provide other services including email services, domain registration, web hosting, and browser packages. An ISP may also be referred to as an information service provider, a storage service provider, an Internet service provider (INSP), or any combination of these three based on the services the company offers.

TABLE 8 SUMMARY OF INTERNET PROVIDERS BY LOCATION

Summary of Internet Providers in Zip Code				14207
Provider	Res/Bus	Type	Coverage	Speed
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon	Res	DSL	99.7%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Verizon Fios	Res	Fiber	3.8%	940 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	94.4%	15 Mbps
Transwave Communications System	Bus	Fixed Wireless	100%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	76.0%	500 Mbps
Crown Castle Fiber	Bus	Fiber	59.0%	1000 Mbps
Verizon Business	Bus	Copper	29.6%	50 Mbps
Spectrum Business	Bus	Fiber	17.8%	940 Mbps
CenturyLink Business	Bus	Fiber	10.8%	1000 Mbps

Summary of Internet Providers in Zip Code				14216
Provider		Type	Coverage	Speed
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon	Res	DSL	96.9%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Verizon Fios	Res	Fiber	37.1%	940 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	92.5%	15 Mbps
Transwave Communications System	Bus	Fixed Wireless	100%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	100%	500 Mbps
Crown Castle Fiber	Bus	Fiber	43.5%	1000 Mbps
Spectrum	Bus	Fiber	16.2%	940 Mbps
Verizon	Bus	Copper	13.0%	50 Mbps
Windstream	Bus	Fiber	6.3%	NA

Summary of Internet Providers in Zip Code				14215
Provider		**Type**	**Coverage**	**Speed**
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon	Res	DSL	97.4%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Verizon Fios	Res	Fiber	53.8%	940 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	92.6%	15 Mbps
Transwave Communications System	Bus	Fixed Wireless	100%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	79.6%	500 Mbps
Crown Castle Fiber	Bus	Fiber	50.1%	1000 Mbps
Spectrum	Bus	Fiber	7.4%	940 Mbps
Verizon	Bus	Copper	3.6%	50 Mbps

Summary of Internet Providers in Zip Code				14214
Provider		**Type**	**Coverage**	**Speed**
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon	Res	DSL	93.5%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Verizon Fios	Res	Fiber	60.7%	940 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	86.9%	15 Mbps
Transwave Communications System	Bus	Fixed Wireless	100%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	100%	500 Mbps
Crown Castle Fiber	Bus	Fiber	51.2%	1000 Mbps
Spectrum	Bus	Fiber	7.4%	940 Mbps
CenturyLink Business	Bus	Fiber	3.4%	1000 Mbps

Summary of Internet Providers in Zip Code				14213
Provider		**Type**	**Coverage**	**Speed**
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon	Res	DSL	100%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	89.7%	15 Mbps
Transwave Communications System	Bus	Fixed Wireless	100%	50 Mbps

Provider	Type		Coverage	Speed
Rooftop Data	Bus	Fixed Wireless	100%	500 Mbps
Crown Castle Fiber	Bus	Fiber	49.5%	1000 Mbps
Spectrum	Bus	Fiber	9.0%	940 Mbps

Summary of Internet Providers in Zip Code				14222
Provider		Type	Coverage	Speed
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon	Res	DSL	100%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	99.2%	15 Mbps
Transwave Communications System	Bus	Fixed Wireless	100%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	100%	500 Mbps
Crown Castle Fiber	Bus	Fiber	59.6%	1000 Mbps
Spectrum	Bus	Fiber	24.8%	940 Mbps
Windstream	Bus	Fiber	9.5%	NA
FirstLight	Bus	Fiber	7.0%	NA
CenturyLink	Bus	Fiber	5.4%	1000 Mbps

Summary of Internet Providers in Zip Code				14209
Provider		Type	Coverage	Speed
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3%	100 Mbps
Verizon	Res	DSL	99.3%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Consolidated Communications	Res	DSL	5.20%	25 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	99.7%	15 Mbps
Transwave Communications System	Bus	Fixed Wireless	100.0%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	100.0%	500 Mbps
Crown Castle Fiber	Bus	Fiber	68.1%	1000 Mbps
Spectrum	Bus	Fiber	21.0%	940 Mbps
Verizon	Bus	Copper	6.6%	1.5 Mbps
CenturyLink	Bus	Fiber	5.0%	1000 Mbps
FirstLight	Bus	Fiber	4.9%	NA
Windstream	Bus	Fiber	2.3%	NA

Summary of Internet Providers in Zip Code				14208
Provider		Type	Coverage	Speed

Provider		Type	Coverage	Speed
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon	Res	DSL	100%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	98.3%	15 Mbps
Transwave Communications System	Bus	Fixed Wireless	100%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	100%	500 Mbps
Crown Castle Fiber	Bus	Fiber	58.3%	1000 Mbps
Spectrum	Bus	Fiber	16.2%	940 Mbps

Summary of Internet Providers in Zip Code				14211
Provider		**Type**	**Coverage**	**Speed**
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon	Res	DSL	100%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	98.7%	15 Mbps
Transwave Communications System	Bus	Fixed Wireless	100%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	83.6%	500 Mbps
Crown Castle Fiber	Bus	Fiber	55.8%	1000 Mbps
Spectrum	Bus	Fiber	6.9%	940 Mbps

Summary of Internet Providers in Zip Code				14201
Provider		**Type**	**Coverage**	**Speed**
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3%	100 Mbps
Verizon	Res	DSL	99.9%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	95.1%	15 Mbps
Transwave Communications System	Bus	Fixed Wireless	100%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	100%	500 Mbps
Crown Castle Fiber	Bus	Fiber	51.7%	1000 Mbps
Spectrum	Bus	Fiber	11.5%	940 Mbps
Windstream	Bus	Fiber	6.8%	NA
CenturyLink	Bus	Fiber	6.8%	1000 Mbps
Verizon	Bus	Copper	4.8%	50 Mbps

Summary of Internet Providers in Zip Code				14212
Provider		**Type**	**Coverage**	**Speed**
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon	Res	DSL	100%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	96.3%	15 Mbps
Transwave Communications System	Bus	Fixed Wireless	100%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	72.8%	500 Mbps
Crown Castle Fiber	Bus	Fiber	29.4%	1000 Mbps

Summary of Internet Providers in Zip Code				14202
Provider		**Type**	**Coverage**	**Speed**
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon	Res	DSL	99.6%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	83.6%	15 Mbps
Transwave Communications Systems	Bus	Fixed Wireless	100%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	100%	500 Mbps
Crown Castle Fiber	Bus	Fiber	59.8%	1000 Mbps
Spectrum Business	Bus	Fiber	30.2%	940 Mbps
CenturyLink Business	Bus	Fiber	19.8%	1000 Mbps
Verizon Business	Bus	Copper	13.0%	50 Mbps
Windstream	Bus	Fiber	11.9%	NA
Cogent Communications	Bus	Fiber	3.4%	1000 Mbps
GTT Communications	Bus	Copper	3.2%	NA
Allstream	Bus	Fiber	2.1%	NA
FirstLight	Bus	Fiber	2.0%	NA

Summary of Internet Providers in Zip Code				14206
Provider		**Type**	**Coverage**	**Speed**
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon	Res	DSL	98.7%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps

Provider		Type	Coverage	Speed
Verizon Fios	Res	Fiber	3.7%	940 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	89.1%	15 Mbps
Transwave Communications Systems	Bus	Fixed Wireless	100%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	74.0%	500 Mbps
Crown Castle Fiber	Bus	Fiber	40.0%	1000 Mbps
Spectrum Business	Bus	Fiber	20.8%	940 Mbps
Verizon	Bus	Copper	10.0%	50 Mbps
Windstream	Bus	Fiber	5.4%	NA

Summary of Internet Providers in Zip Code				14210
Provider		**Type**	**Coverage**	**Speed**
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon	Res	DSL	99.4%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Verizon Fios	Res	Fiber	20.7%	940 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	89.4%	15 Mbps
Transwave Communications Systems	Bus	Fixed Wireless	100%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	97.2%	500 Mbps
Crown Castle Fiber	Bus	Fiber	50.3%	1000 Mbps
GTT Communications	Bus	Copper	5.4%	NA
Spectrum	Bus	Fiber	5.0%	940 Mbps

Summary of Internet Providers in Zip Code				14203
Provider		**Type**	**Coverage**	**Speed**
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon	Res	DSL	98.2%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	97.5%	15 Mbps
Transwave Communications Systems	Bus	Fixed Wireless	100%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	100%	500 Mbps
Crown Castle Fiber	Bus	Fiber	51.8%	1000 Mbps
Spectrum Business	Bus	Fiber	26.4%	940 Mbps
CenturyLink Business	Bus	Fiber	20.4%	1000 Mbps
Verizon Business	Bus	Copper	17.9%	50 Mbps
Windstream	Bus	Fiber	3.2%	NA

Summary of Internet Providers in Zip Code				14220
Provider		**Type**	**Coverage**	**Speed**
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon	Res	DSL	98.6%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Verizon Fios	Res	Fiber	56.9%	940 Mbps
Spectrum	Bus	Cable	100%	1,000 Mbps
Verizon High Speed Internet	Bus	DSL	97.6%	15 Mbps
Transwave Communications Systems	Bus	Fixed Wireless	100%	50 Mbps
Rooftop Data	Bus	Fixed Wireless	56.8%	500 Mbps
Crown Castle Fiber	Bus	Fiber	38.0%	1000 Mbps
Spectrum Business	Bus	Fiber	13.9%	940 Mbps

Summary of Internet Providers in Zip Code				14204
Provider		**Type**	**Coverage**	**Speed**
Spectrum	Res	Cable	100%	1,000 Mbps
T-Mobile	Res	Fixed Wireless	3.0%	100 Mbps
Verizon Fios	Res	Fiber	73.2%	940 Mbps
Verizon	Res	DSL	73.2%	15 Mbps
Viasat	Res	Satellite	100%	100 Mbps
HughesNet	Res	Satellite	100%	25 Mbps
Spectrum Business	Bus	Cable	100%	1,000 Mbps
Verizon Business	Bus	DSL	73.6%	15 Mbps
Transwave Communications Systems	Bus	Fixed Wireless	100%	50 Mbps
Crown Castle Fiber	Bus	Fiber	20.5%	1000 Mbps

5. Interviews

5.1 Technology Meeting

August 19, 2021

Attendees:
Jim Finn – Manager of Network Operations at M&T Bank (Retired)
Steven Heist – Director of Network and Communication Services at University at Buffalo
Christine Carr-Barmasse – Executive Director Mission: Ignite
Daryl Springer – Chief Information Officer at City of Buffalo
Alex Carducci – Real Estate Financial Analyst at City of Buffalo
Lisa Hicks – Director of Development at City of Buffalo
Jeff Brooks – Broadband Analyst
Andy Lukasiewicz – Director Broadband Services ECC Technologies

The panel discussed the lack of broadband availability in the City of Buffalo. In particular, the panel focused in on an area of the city known as the Fruit Belt. The Fruit Belt is a residential area located on the eastern side of the city of Buffalo, NY adjacent to the Buffalo Niagara Medical Campus.

The field inventory shows that DSL and CATV services are available in the area.

The Fruit Belt residents have access to Spectrum Cable and Verizon DSL. Verizon Claims their DSL service in the area will provide speeds from 0.5 Mbps to 15 Mbps depending upon the equipment used and the quality of the phone lines leading to the home or business.

ECC used 142 Peach Street, Buffalo, NY 14204 as a sample address in the Fruit Belt to obtain service availability, speeds and pricing from Verizon and Spectrum. The address was input in the Verizon Site to which resulted in only one service level being listed with speeds up to 0.5 to 1Mbps and priced at $29.99/month.

Upon reviewing a street view map, coaxial cable can be seen running along poles in front of the address. Speeds available from Spectrum include 200 Mbps x 10Mbps for $49.99/month, 400 Mbps x 20 Mbps for $69.99/month and 1Gbps x 35 Mbps for $109.99/month. The process was laborious as there was no confirmation from the Spectrum web site. Instead, we were directed to call to confirm if service was available. Spectrum was booking out 9 days for installations but required a technician to be sent out three days prior to confirm availability at the location.

The panel discussed the $300K grant award from Project Overcome to provide broadband service to 150 homes in the Fruit Belt. A 25 Mbps x 3Mbps service will be provided via a private LTE wireless service emanating from antennas located atop Buffalo General Hospital. Initially the service will be at no charge for the first year. Thereafter, the service will be $10/month. This technology coupled with equipment and the training of digital literacy are key to the program's success.

The panel also discussed the importance of broadband access to the community centers to help with the education of digital literacy. One key example is the Johnny B. Wiley Community Center. Only DSL is available which provides inadequate speeds. Spectrum TV is across the street from the center. However,

the Center was quoted over ████████ construction fee. This appears to be due to the requirement for an underground build from the pole line to the center.

The panel recognized that several groups are working to resolve broadband issues in the community. All groups are acting as independent islands holding separate periodic meetings. It was recommended that the groups come together and work in a united fashion to address broadband availability, choice in providers, pricing, and digital literacy.

5.2 Community Meeting

September 13, 2021

Attendees:

Derrick Parson – Director of Beverly Gray Center
Jason Drayton – Pastor First Cavalry Missionary Baptist Church
Christine Carr-Barmasse – Executive Director Mission: Ignite
Daryl Springer – Chief Information Officer at City of Buffalo
Lisa Hicks – Director of Development at City of Buffalo
Kurt Frenzel – Broadband Analyst
Andy Lukasiewicz – Director Broadband Services ECC Technologies

The Beverly Gray Center is a not-for-profit organization that provides technical, funding identification and other types of assistance to minority businesses that are just starting out or need assistance. They are an organization located on the east side of Buffalo and is in a "marginal area" for broadband service.

They are a "one stop shop" for assistance. At their peak they have 8 staff members to assist businesses that need help. Derrick considers himself as an entrepreneur, assisting with business development.

People that they work with bring their own technology to the incubator center. They bring laptops, tablets, cell phones and more. They claim to have up to 100 people a day visiting this location. They have businesses members of the organization that can help other businesses with websites and other type of online commerce such as branding and marketing.

The Center currently subscribes to Spectrum. The center does not have a viable alternative at this time. another choice. Mr. Parson stated, Verizon doesn't offer anything and has turned them down for providing new service. He would like to see more competition in his area. Ideally, a fiber based 1 Gig service would be the most appropriate bandwidth to support their efforts. Their backup is a Verizon 5G wireless service. Mr. Parson would prefer a form of landline service for backup.

Mr. Parson would like to see his organization as a "gateway to the community" with Wi-Fi throughout the area, including the houses in the general vicinity. He believes the center needs the same technology/broadband resources as a college or university.

The First Cavalry Baptist Church is in the process of building a new sanctuary that is connected to their current location. This location will support a computer lab space for the community. "They have challenges with certain types of access."

The church currently subscribes to Spectrum service. They are getting a new "business class" service which will be fiber based and 20 Mbps. Having a backup second connection is a concern. And he would like to see more options for service. Currently, Spectrum is their only real option as Verizon is not offering them any solutions. Pastor Drayton is concerned about church services being interrupted by bad connections. He is also concerned about the cost of broadband service. Every dollar they spend on broadband is a dollar they cannot use somewhere else to help the needy.

The church provides religious services online through a live stream on YouTube and Facebook. In the past some of his church members have complained about home access with screen freezes and pauses during the church service. Also, there are neighborhoods on the East side of Buffalo where some members of the congregation have access to broadband and others that do not.

Per Christine Carr-Barmasse, there are two community centers that have learning labs – Johnny B. Wiley at 1100 Jefferson Ave, and the Promise Land Missionary Baptist Church at 243 Mulberry St. Remote healthcare is big issue in the community. Community access points are key.

The Fruit Belt Pilot program will include an antenna on the top of Buffalo General Hospital where a dedicated private LTE service will be provided to 150 homes and the learning labs.

Greenlight Networks is a welcome new provider in the city, but they are focused on building to a small area on the west side of the city. Ms. Carr-Barmasse would like to see more competing ISPs to bring down the cost to end users.

Mission: Ignite provides Broadband, Equipment, and training to use the Internet.

It was noted there is a significant generational gap in the community. People do not understand how to use the technology. It is impacting education and family goals. Teaching digital literacy is key along with affordable broadband.

5.3 City of Buffalo OSP/DPW/MIS

September 15, 2021

Attendees:
Brendan Mehaffy – Executive Director, Office of Strategic Planning at City of Buffalo
Michael J. Finn – Commissioner Public Works, Parks and Streets at City of Buffalo
Daryl Springer – Chief Information Officer at City of Buffalo
Alex Carducci – Real Estate Financial Analyst at City of Buffalo

The panel provided an overview of their meeting with Greenlight Networks. This included acknowledgement of a 4 year build out plan by Greenlight. The establishment of a standard firehouse agreement for co-locating electronics. A dig once policy was discussed along with the city's 5 year moratorium on underground construction.

The city has fiber infrastructure to all city buildings, fire halls, police stations and emergency services locations. Fiber exists to some of the DPW locations but not all.

The city has a priority to ensure there is access to 7 community center locations at the following addresses and asked for an analysis of service availability.

Location	Address	Service Availability
Asarese-Matters Community Center	50 Rees Street, 14213	CATV fiber and COAX are on pole line in front of building
Hennepin Park Community Center	24 Ludington Street, 14206	CATV nearby but requires underground construction
JFK Community Center	114 Hickory Street, 14204	CATV nearby but requires underground construction
Lincoln Senior Center	10 Quincy Road, 14212	CATV available via pole line
Tosh Collins Community Center	35 Cazenovia Street, 14206	CATV nearby but requires underground construction
Northland	683 Northland Avenue, 14211	CATV fiber and COAX are on pole line in front of building
Clinton Machina Center	1799 Clinton Street, 14206	CATV fiber and COAX are on pole line in front of building

TABLE 9 COMMUNITY CENTER LOCATIONS

Four of the seven locations should be relatively straight forward to obtain broadband service through Spectrum. Three locations appear to require underground construction.

5.4 Greenlight Networks

September 21, 2021

Attendees:
David Grabert –Vice President of Engineering - Greenlight Networks
Lori White –Government, Community & Public Affairs - Greenlight Networks
Patrick Amering – Director of Regulator Operations – Greenlight Networks
Patrick Farnung – Director of Outside Plant Engineering – Greenlight Networks
Lou Goetzman – Director of Network Engineering and Operations – Greenlight Networks
Daryl Springer – Chief Information Officer at City of Buffalo
Alex Carducci – Real Estate Financial Analyst at City of Buffalo
Lisa Hicks – Director of Development at City of Buffalo

Greenlight Networks is a Fiber to the Premise Internet Service Provider based in Rochester, NY. Greenlight is currently constructing and planning to construct fiber-based services in the western section of the city of Buffalo. They arrange agreements with firehalls to place their electronic hubs.

Greenlight has a four-year build plan. However, they have been running into roadblocks to their progress. Greenlight struggles to get timely permits from the city. There is a 5-year moratorium on underground construction. The city policy restricts construction within the drip line of trees. Greenlight has been put on a 60-day delay for a 6,000ft underground construction. Aerial permits have an excessively slow turn around within the city.

Working with Verizon has also been an issue. When Greenlight requests a map and underground search for available conduit they typically wait up to 60 days. Once confirmed, Greenlight must wait another 60 days for approval. When requesting make ready on poles, Verizon will agree to the make ready work on paper. However, once they get into the field, Verizon will challenge the agreed to make ready causing the cycle to start over again causing major delays.

Greenlight is encouraged and looks forward to working with the city to address these issues.

5.5 Empire Access

September 21, 2021

Attendees:
Jim Baase – COO, Empire Access
Andy Lukasiewicz – Director of Broadband Services, ECC

Empire Access is a CLEC fiber to the home provider. They provide Internet, CATV, voice and security services over their fiber to the home network. Empire has a presence in Batavia and their network extends as far west as Pembroke and Corfu.

Empire would be very interested in offering services in Buffalo. However, they are not interested in offering services where Verizon Fios or Greenlight Networks are servicing customers.

5.6 Verizon Wireless

Mark Coon - Sr. Manager - Small Cell Real Estate/Regulatory, Verizon
Daryl Springer – Chief Information Officer at City of Buffalo
Alex Carducci – Real Estate Financial Analyst at City of Buffalo
Joe Starks – President, ECC
Justin Zagorski – Marketing Manager, ECC
Andy Lukasiewicz – Director of Broadband Services, ECC

Verizon wishes to deploy 500 to 600 5G ultra-wideband small cells in the city of Buffalo over the next 4 years. Each of these small cells will be fed by fiber optic cable. From these small cells, Verizon will be able to offer residents up to 1 Gbps download and 50 Mbps upload speeds from $50 - $70/month.

Verizon feels they can launch their service with ⅓ to ½ of the city covered. Verizon negotiated a franchise agreement with the city that complies with FCC regulations. However, the city's Chapter 440 Telecom Ordinance is at odds with FCC regulations and is impeding Verizon progress. Issues that need resolution include:

The city's prohibition on new poles.

The limitation by the city of 3 cubic feet maximum for equipment, which is at odds with the FCC. Also, the equipment to be used by Verizon will exceed this size.

Verizon needs the access to city rights of way access to backyard poles. ILEC's and CLEC's have access but not cellular providers.

The city is reviewing the aesthetics portion of the Chapter 440 code. The city council is targeting changes for the November 2021 council meeting.

6. Summary of Findings:

In summary, based on the information gathered in this study, broadband infrastructure is available within a few hundred feet of city residents and businesses.

Verizon offers fiber to the home predominately in the Northern portions of the city in the University, Delaware, and North Districts. In addition, FTTH is available in the South District. Other areas are served by slow DSL service. However, Verizon has elected to no longer expand its FIOS service. Instead, the company is focusing on its 5G cellular deployment.

Greenlight Networks is establishing its FTTH service in the western portion of the city in the Niagara District. Construction began in 2021. Greenlight has a 4-year plan to expand their service in the city. However, the current city underground ordinances are very restrictive. A five-year moratorium on underground construction impedes the ability for Greenlight and other providers from expanding services in the city. The delays in permitting, code restrictions and lack of timely cooperation by Verizon for conduit access makes for a difficult and challenging environment from which to expand rapidly.

The city residents and businesses have access to Spectrum Internet. However, in areas where the customer needs to be served via underground pathway, the costs to run the cable can be costly and prohibitive to broadband adoption.
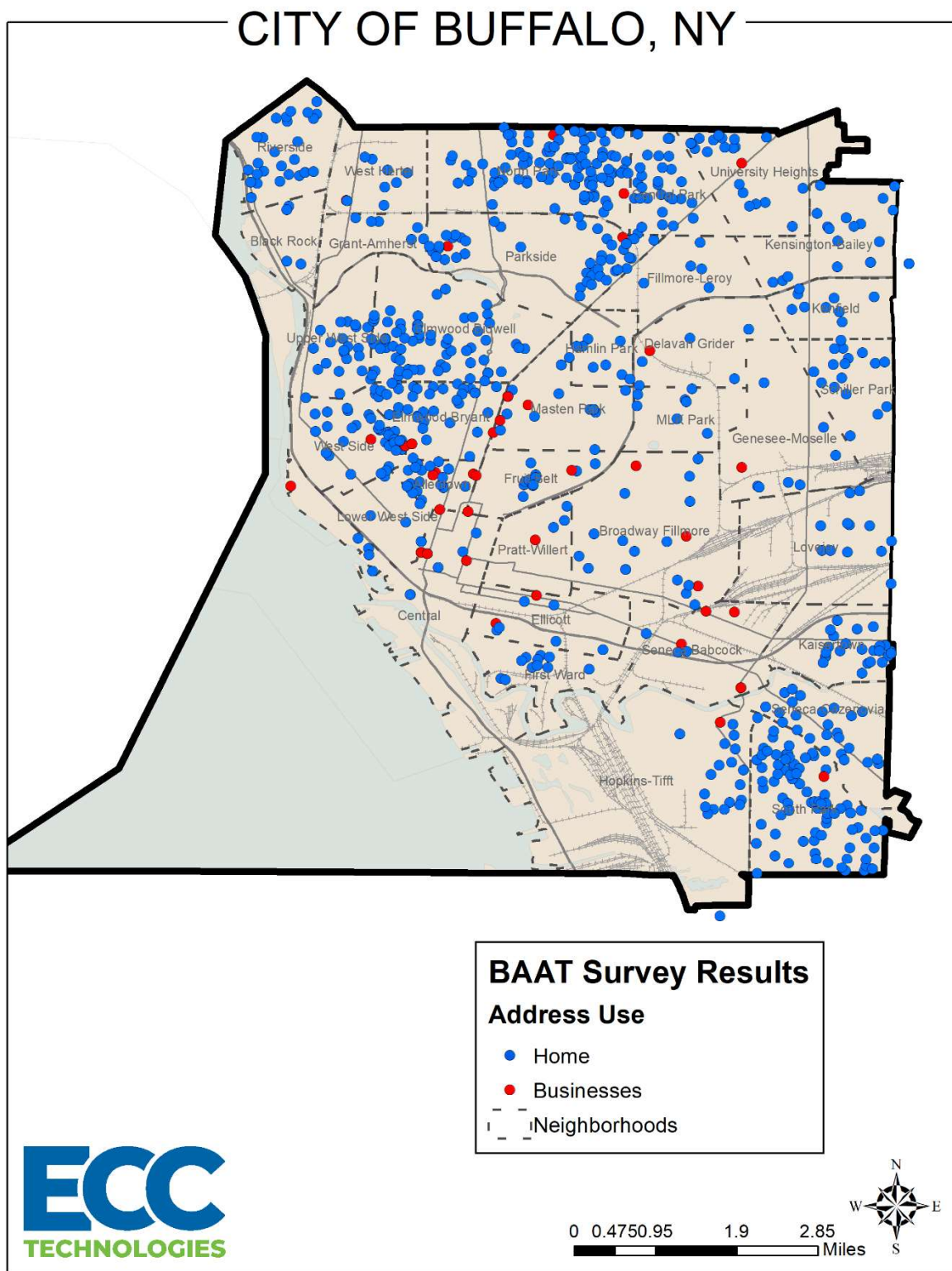
Although many of the residential areas have access to infrastructure via pole lines running along their backlots, the main feeder infrastructure is fed via a labyrinth of underground facilities along main and secondary roads.

Verizon Wireless has plans to expand their 5G cellular service throughout the city. Verizon is looking to add 500 to 600 small cells in the city. However, Verizon needs access to poles and streetlights to mount their antennas and electronics. Verizon needs access to city rights of way to access pole lines running in backlots.

University at Buffalo and Mission:Ignite have worked together to secure a $300,000 grant from the National Science Foundation's Project Overcome program. This grant will be used to provide wireless broadband to 150 homes in the Fruit Belt in Buffalo. This program combines free/low-cost Internet access, with low-cost equipment in combination with educating the users on the benefits and use of the Internet.

The vast majority of the city residents have access to Spectrum cable or slow DSL from Verizon. Based upon the feedback from respondents of the BAAT survey, most feel Spectrum has a monopoly on internet service in the city. The respondents desire other alternative provider to compete with Spectrum. Many are not happy with the reliability and customer service Spectrum provides. The respondents also indicated that the price for Internet service is too expensive.

A visual of some of the BAAT survey responses can be found on the following pages. Figure 21 shows the location of the responses while Figure 22 shows responses pertaining to the ability to obtain the speeds needed.

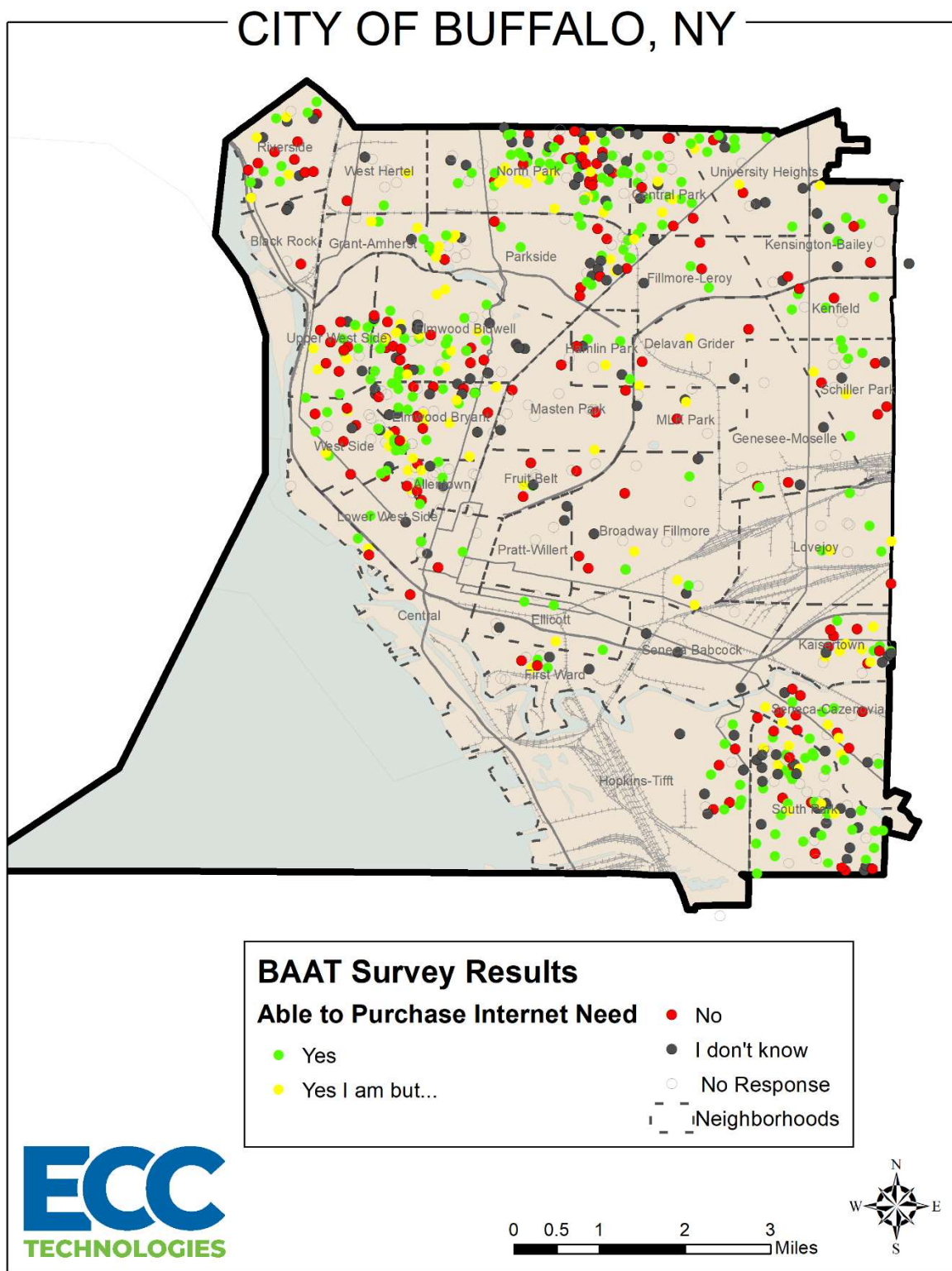**FIGURE 21 BAAT RESPONSE LOCATIONS BY TYPE**

CITY OF BUFFALO, NY

BAAT Survey Results

Able to Purchase Internet Need

- Yes
- Yes I am but...
- No
- I don't know
- No Response
- Neighborhoods

ECC TECHNOLOGIES

FIGURE 22 BAAT SURVEY RESPONSES - ABLE TO PURCHASE THE SPEED NEEDED

7. Recommendations/Next Steps

Issues:

The Broadband Inventory and Broadband Availability and Adoption Tool Survey uncovered several key issues driving the availability and adoption of broadband in the city of Buffalo. These issues include:

1.) Lack of choice in broadband provider (92% believe it is important or very important to have a choice of providers.)
2.) High cost of service, (nearly 50% of respondents are paying $75/month or more for service)
3.) High cost to provisioning the service, (12% claimed Internet was not available)
4.) Education on the benefits of and how to use the Internet. (6% claimed lack of skills and knowledge to use the Internet)
5.) Availability of affordable equipment. (6% sited lack of a computer or a device)

Strategies for Solutions:

Below possible solutions for addressing the City's broadband issues are addressed. These solutions are broken down by actions that can be taken in the short term (over the next 12 months), medium term (1-2 years), and long-term (2+ years).

Short Term Strategies (over the next 12 months):

1.) Emergency Broadband Benefit Program:

To immediately address *cost issues*, the city should consider leveraging the Emergency Broadband Benefit program by marketing the availability of the program informing residents of the benefits, costs, qualifications, and assistance with processing applications.

In the Consolidated Appropriations Act of 2021, Congress appropriated $3.2 billion to the FCC to help low-income households pay for broadband service and connected internet devices.

The Emergency Broadband Benefit (EBB) Program will provide a discount of up to $50 per month for broadband services for eligible consumers. Consumers who live on qualifying Tribal lands can receive enhanced support of up to $75 per month toward broadband services.

Additionally, the program provides a one-time device discount of up to $100 for a laptop, desktop computer, or tablet purchased through a participating provider. The one-time discount requires a consumer co-payment of more than $10 and less than $50.

The Emergency Broadband Benefit is temporary. It is set to expire on 12/31/2021. However, Congress recently created the Affordable Connectivity Program, a new, long-term $14 billion program that will

replace the Emergency Broadband Benefit Program on January 1, 2022. The program was established for the FCC to help low-income households pay for broadband service and connected internet devices.

The Affordable Connectivity Program will provide a discount of up to $30 per month for broadband services for eligible consumers. Households qualifying on Tribal lands will be able to receive $75 per month.

Households enrolled in the EBB Program as of December 31, 2021, will continue to receive their current monthly benefit during a 60-day transition period.

2.) Create a fund for hardship cases and low-income households.

Although broadband service is near homes and businesses within the city, it can be ***costly to provision the service*** constructing the drops connecting the home to the distribution infrastructure of the provider. Although the infrastructure is only a few hundred feet away from the address, there are instances where the residence or business claim they need to pay upwards of $20K for an installation.

To address the high cost of broadband, either installation costs or monthly costs, the city could allocate a portion of the franchise fees collected from Spectrum and Verizon into a pool to be used to help reduce these costs for the needy households.

3.) Establish a Broadband Committee

The city could create a broadband committee to meet periodically with all broadband providers offering services in the city to understand their plans and needs and work cooperatively with the providers to expedite expansion. Through this cooperative effort the city could perhaps influence the timing and location of expansion to critical parts of the city that need it the most. This committee could also meet with regional providers not currently providing services to entice expansion into Buffalo. This committee could also be responsible for exploring various grant opportunities to expand broadband. With the passage of the new infrastructure bill which includes $65 billion to improve high speed internet access and affordability the City could leverage these funds to expand broadband competition and improve affordability.

The infrastructure bill includes:

- ***$42.45 billion in grants to states for broadband projects, which can range from network deployment to data collection*** to help determine areas that lack service.
- ***$14.2 billion to provide a $30-a-month voucher to low-income Americans to pay for internet service***. It will replace the current $50-a-month Emergency Broadband Benefit program, offering less money monthly, but increasing the number of those eligible.
- ***$2.75 billion for digital inclusion and equity projects, such as improving digital literacy or online skills for seniors.***

- $2 billion each for a rural broadband construction program called ReConnect, run by USDA, and to the Tribal Broadband Connectivity Program run by the Commerce Department's National Telecommunications and Information Administration (NTIA).
- $1 billion to build so-called "middle mile" infrastructure to connect local providers to larger internet access points.
- $600 million for private activity bonds to finance broadband deployment projects in rural areas.

Medium Term Strategies (1-2 years):

4.) Provide an environment to embrace ISP expansion.

Having *viable competition in broadband service providers* is essential to drive prices down and improve service quality. The city should consider:

- **Consider adoption of a dig once policy.**
  Some reasons to implement a Dig Once policy include a reduction in deployment costs, encouraging competition among internet service providers, and working to close the digital divide. Current policies in place focus less on direct deployment of fiber to communities, but by increasing the conduit that is available, telecommunications providers can more easily move into a town that was previously at a disadvantage.

  Further, the implementation of Dig Once policies can advance government interests by, ensuring fast and efficient deployment of telecommunication networks. Reducing costs by coordinating among departments and decreasing disruptions to the community and roads, improving aesthetic beauty of neighborhood by undergrounding lines. Dig Once policies can be used in a variety of ways, such as aiming to connect residents, businesses, and mobile cell sites. It can also save taxpayer dollars and maximize the space available in the right-of-way. Whenever there is digging of sidewalks or roadways, the city should place a minimum of two 4" conduits.

- **Loosening code restrictions that restrict underground construction**

- **Provide Cellular providers access to city rights of way**

- **Streamline permitting and approval processes.**

5.) Welcome 5G Cellular Service

5G service could be a game changer for city resident providing up to 1Gbps service and in home Wi-Fi access. In addition, the city could take advantage of 5G availability help develop Buffalo into a Smart City. The city should consider the following:

- The city could create a committee to meet periodically with cellular providers offering services in the city to understand their plans and needs, develop programs to ease and speed deployment and potentially influence the providers in their expansion.
- allow wireless carriers access to city rights of way.
- matching city codes and regulations to federal regulations pertaining to size of equipment allowed on poles.
- allow wireless carriers affordable access to city vertical assets such as streetlights.

6.) Invest in providing access to the city community centers.

The community centers can be key locations for *educating the community in the benefits and use of the Internet*. The cost to provision infrastructure to some of the community centers is costly due to the requirement of underground construction. The city should consider funding the construction needed to bring acceptable service to the community centers. Perhaps the city could consider use of the ARPA funds for this purpose. Assuming $30,000/community center location and 5 centers, a $150,000 budget should cover most of the construction costs to the centers.

Perhaps, funding could be obtained through the new infrastructure bill recently passed to pay for the installation of service, equipment, and digital literacy.

Long Term Strategies (2+ years):

7.) ErieNet

Erie County through a is endeavoring to build a 400-mile open access dark fiber network (ErieNet), to connect county facilities, PSAP's and libraries. They plan to make available non-allocated fiber optic strands available for lease by government, enterprise, healthcare, education, providers, or any entity requiring the use of the fiber optic infrastructure. The County is currently refining the routing and business plan prior to construction. The routing and business plan are expected to be completed in February 2022. Design and construction of the network is expected to take 2-3 years.

The city currently leases services from providers to connect 38 locations. Of the 38 city locations, 24 subscribe to 2 Mbps service or less, 7 locations subscribe to 10 Mbps, 6 locations subscribe to 50 Mbps while 1 site subscribes to 500Mbps. Thirty-two locations are served by bandwidth not considered broadband speeds by the FCC. These services cost the city roughly $13,000/month. In addition, some

community centers, though very close to broadband infrastructure, require significant installation costs to bring the broadband a few hundred feet to their buildings.

The city should work cooperatively with and support Erie County's efforts to establish ErieNet open access dark fiber network. Leveraging this network could allow the city to save on costs for fiber connection to city and DPW sites as well as provide diverse routing for disaster recovery. In addition, the city may be able to influence the County on network routing to enable the city to better take advantage of the network.

Examples of this including the routing of the network to community centers and city locations.

For nearly the same amount as the city is paying for its connectivity, the city could lease dark fiber from ErieNet and serve each location with 1 Gbps to 10 Gbps service or up to 500 to 5,000 times the bandwidth to which they are currently subscribing. This could dramatically improve data transfer effectiveness for applications, transactions, and backup recovery.

8.) Build the Foundation for a Smart City/Create a City Owned Network

Cities are getting "smarter" to provide for improved delivery and quality of services including sanitation, public safety, traffic congestion, tax collection, maintenance of public facilities, and emergency services. This is accomplished through continuous monitoring of residents and infrastructure, and relatively instantaneous communication of suboptimal performance. To a large extent, this requires heavy reliance on automation, connectivity to the internet, and what is referred to as the "Internet of Things (IoT)." (Internet of Things refers to connecting devices to the internet that can be controlled or can be used to send control information).

A smart city, then, is a city in which a suite of sensors (typically hundreds or thousands) is deployed to collect electronic data from and about people and infrastructure to improve efficiency and quality of life. Residents and city workers, in turn, may be provided with apps that allow them to access city services, receive and issue reports of outages, accidents, and crimes, pay taxes, fees, and the like. In the smart city, energy efficiency and sustainability are emphasized.

The City of Buffalo could on its own or work in conjunction with a public/private partnership, develop its own city-wide network. Applications include deployment of a smart traffic flow management system.

The smart traffic control management system can combine a central control system with controls for traffic lights and sensors for detecting delays or the amount of traffic at intersections. The control system can adjust the timing of the lights based on the amount of traffic and how well that traffic is flowing. Some systems can adjust timing, for example, for buses or emergency vehicles as well. Further, some systems

may monitor conditions (or receive reports of conditions) on main highways and major roads and adjust timing on major roads and alternate routes to compensate.

Old streetlights can be replaced with those using more efficient light-emitting diodes, or LEDs. These new streetlights can also support cameras and other sensors for monitoring crowds or high-traffic areas. Sensors can even be installed to monitor pollutants. The city of Raleigh, North Carolina implemented cameras on buildings and streetlights for public safety purposes to respond quicker to crimes and other emergencies. This has reduced crime rates there dramatically.

Parking meters may, for example, be equipped with sensors or other monitors that communicate with a central server and a user app to advise when a parking spot is available and guide a driver to it. Such meters may be able to automatically charge a parker for using the spot and advise the user and, potentially, law enforcement when the meter time has expired.

APPENDIX

Appendix A - Provider Service, Speeds and Costs

Spectrum

Residential 7 Village Ln 14212

Internet Assist
Get high-speed Internet with no data caps

$14.99/mo

Pricing Info

Eligible for Emergency Broadband Benefit. Learn more

Speeds up to **30** Mbps

CHOOSE

Read more

YOU QUALIFY FOR INTERNET AT AN AFFORDABLE PRICE

Internet 50
Surf and stream with ease-Internet 50 provides plenty of speed and bandwidth

$29.99/mo
for 24 mos.

Pricing Info

Eligible for Emergency Broadband Benefit. Learn more

Speeds up to **50** Mbps

CHOOSE

Read more

Internet
Get high-speed Internet with no data caps

$49.99/mo
for 12 mos.

Pricing Info

Eligible for Emergency Broadband Benefit. Learn more

Internet Ultra
Go faster and turbo charge all your devices with Internet Ultra

$**69** 99/mo
for 12 mos.

Pricing Info

Eligible for Emergency Broadband Benefit. Learn more

Speeds up to **400** Mbps

CHOOSE

Spectrum BUSINESS

Business 7 Village Ln 14212

200 Mbps BUSINESS INTERNET + VOICE	200 Mbps INTERNET + VOICE + TV ESSENTIALS	600 Mbps BUSINESS INTERNET + VOICE
$**69**98/mo for 12 mos when bundled*	$**89**97/mo for 12 mos when bundled***	$**114**98/mo for 24 mos when bundled**
LEARN MORE	**LEARN MORE**	**LEARN MORE**
200 Mbps Speed / 35+ Calling Features	200 Mbps Speed / 35+ Calling Features / 60+ HD Channels	600 Mbps Speed / 35+ Calling Features

T | HOME INTERNET

3% Coverage in Buffalo

high-speed internet for only $50/mo.

with AutoPay via a $10/mo. bill credit

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Verizon Fios

Residential 254 Woodland Dr 14223

Fios Home Internet: 200 Mbps	$39.99
Fios Home Internet: 400 Mbps	$64.99
Gigabit Connection	$89.99

verizon✓

DSL Residential 254 Woodland Dr 14223

200 Mbps Speed	Starting at $39.99
400 Mbps Speed	Starting at $59.99
Gigabit Connection	**Starting at $79.99**

Verizon Fios

Business 254 Woodland Dr 14223

100/100 Mbps	300/300 Mbps	Gigabit Connection Up to 940/880 Mbps
One-year price guarantee	Two-year price guarantee	Three-year price guarantee
$69/mo	**$129/mo**	**$249/mo**
Plus taxes, fees and equipment charges. Offer & pricing details.	Plus taxes, fees and equipment charges. Offer & pricing details.	Plus taxes, fees and equipment charges. Offer & pricing details.
+$25/mo for one Business Digital Voice line	+$10/mo for one Business Digital Voice line	+One Business Digital Voice line included
	+No activation fee (save $49)	+No activation fee (save $49)

verizon✓

DSL Business 254 Woodland Dr 14223

Download speeds (up to) 10 Mbps	Download speeds (up to) 25 Mbps	Download speeds (up to) 50 Mbps
1 Year Price Guarantee	2 Year Price Guarantee	3 Year Price Guarantee
25GB Premium Network Access	50GB Premium Network Access	150GB Premium Network Access
300GB Monthly Data Allowance	300GB Monthly Data Allowance	300GB Monthly Data Allowance
ⓘ	ⓘ	Router Included*
		ⓘ
Starting at **$69/mo**	**Starting at** **$99/mo**	**Starting at** **$199/mo**
Plus taxes, fees and equipment charges	Plus taxes, fees and equipment charges	Plus taxes and fees. Router included*

Viasat

159 Hollywood Ave 14220

UNLIMITED BRONZE 12		UNLIMITED SILVER 25		UNLIMITED GOLD 30		UNLIMITED PLATINUM 30	
Download speed up to 12 Mbps	Upload speed up to 3 Mbps	Download speed up to 25 Mbps	Upload speed up to 3 Mbps	Download speed up to 30 Mbps	Upload speed up to 3 Mbps	Download speed up to 30 Mbps	Upload speed up to 3 Mbps
$64.99/mo		**$84.99/mo**		**$119.99/mo**		**$169.99/mo**	
$84.99/mo after 3 months		$119.99/mo after 3 months		$169.99/mo after 3 months		$249.99/mo after 3 months	
✓ Up to 360p Video Streaming		✓ Up to 480p Video Streaming		✓ Up to 720p Video Streaming		✓ Up to 1080p Video Streaming	
✓ The Unlimited Bronze 12 plan includes Unlimited data.		✓ The Unlimited Silver 25 plan includes Unlimited data.		✓ The Unlimited Gold 30 plan includes Unlimited data.		✓ The Unlimited Platinum 30 plan includes Unlimited data.	

HughesNet.

254 Woodland Dr 14223

Most popular	Best value

10GB
~~59.99~~ 39.99/mo.
Offer ends 9/28/2021
$20 Off 6 Months[13]

20GB
~~69.99~~ 49.99/mo.
Offer ends 9/28/2021
$20 Off 6 Months[13]

30GB
~~99.99~~ 79.99/mo.
Offer ends 9/28/2021
$20 Off 6 Months[13]

50GB
~~149.99~~ 129.99/mo.
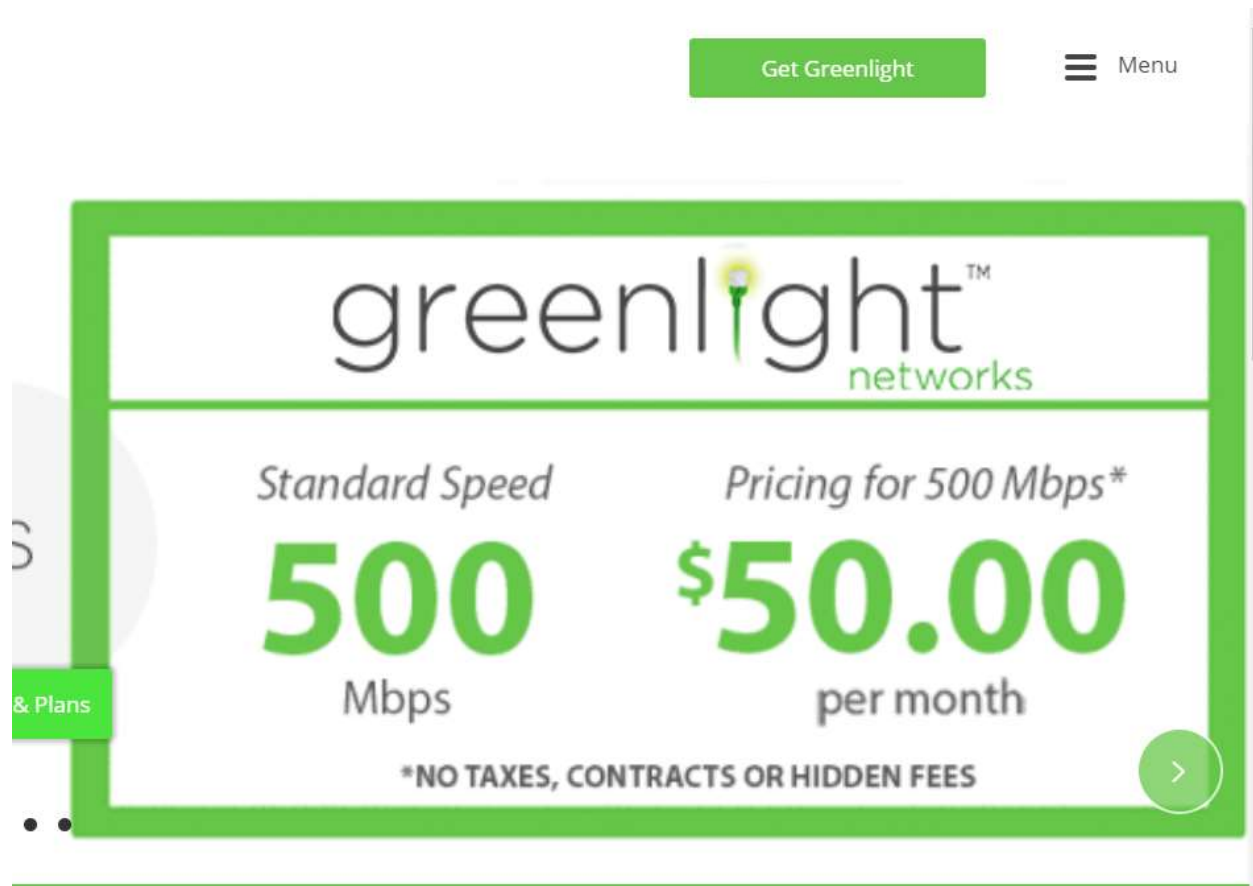Offer ends 9/28/2021
$20 Off 6 Months[13]

kinetic business
by windstream.

14206

Fiber Internet

Speeds up to 1 gig on our fiber-backed network.
Unlimited flexibility and scalability for what's next.

Starting At

$57.75 / mo.*

* for 24 months. Requires 24-month agreement

GreenLight Internet (pricing is for existing service in areas they have built ftth)

Appendix B - Glossary (Selected Terms)

BACKBONE. Backbone, in the context of networking, refers to the highest speed and widest bandwidth point of a communications circuit or path. In most cases, all information central to the users is connected to the backbone (e.g., shared databases or servers).

BANDWIDTH. Bandwidth is the amount of data that can be carried by a circuit between two points of a network. Bandwidth is typically measured in Hertz (cycles per second), bits per second or kilobits per second (shortened to Bps or Kbps). The top speed of today's modems is 56,000Bps or 56Kbps.

The wire connecting a private home to the telephone company carries up to 128,000Bps while one strand of fiber optics can carry 20,000,000,000 (20 Gigabits). A 20Gbps fiber optic strand can interconnect 357,000 telephone calls.

8 bits equal one byte of data – a byte is generally the same as one character – for example the letter "a."

BROADBAND. Broadband is a descriptive term for evolving digital technologies that provide consumers a signal switched facility offering integrated access to voice, high-speed data service, video-demand services, and interactive delivery services.

COPPER/COPPER CABLE - Traditional telephone copper cable is still the most used infrastructure serving homes and businesses. Telephone companies use copper cable to connect Central Offices to end users for the purpose of providing traditional voice and data services, typically referred to as broadband.

FIBER/FIBER CABLE - Fiber-optic cable, also known as an optical-fiber cable, is an assembly similar to an electrical cable, but contains one or more optical fiber(s) that are used to carry light. The optical fiber elements are typically individually coated with plastic layers and contained in a protective tube suitable for the environment where the cable is used.

CATV (Cable Television System). A broadband communications system capable of delivering multiple channels of programming from a set of centralized satellite and off-air antennae, generally by coaxial cable, to a community. Many cable-television designs integrate fiber-optic and microwave links.

A service through which subscribers pay to have local television stations and additional programs brought into their homes from an antenna via a coaxial cable.

CENTRAL OFFICE (CO). A CO is a major equipment center designed to serve the communications traffic of a specific geographic area. CO coordinates are used in mileage calculations for local and interexchange service rates. A Central Office usually has less than 100,000 telephone lines within its wire boundary. COs are usually owned and operated by LECs.

CLEC (Competitive Local Exchange Carrier). A CLEC is a telephone company that competes with the incumbent telephone company. The formation of these organizations is a direct result of the Telecommunications Act of 1996.

CABLE/COAXIAL CABLE. A type of cable used for broadband data and cable systems. Also known as "coax." Coaxial cable is composed of an insulated central conducting wire wrapped in another cylindrical conducting wire. It is usually wrapped in another layer and an outer protective layer and has the capacity to carry great quantities of information.

DARK FIBER. Dark Fiber is fiber optic cable, typically between end user locations, that the end user owns, lights, and operates.

DSL (Digital Subscriber Line). DSL is technology that allows for the simultaneous transmission of voice and Internet data over a single telephone line. Central Offices that have DSL technology can support DSL services to customers within approximately 18,000 feet of the Central Office.

DSL is delivered either asymmetrically (ADSL) or symmetrically (SDSL). ADSL lines have download transmission rates higher than upload rates and are typical for residential or business users that receive much more Internet content than they send. SDSL are for businesses that generate and receive large amounts of Internet data.

DOWNLOAD SPEED. The rate at which data is transferred from the Internet to the user's computer is termed download speed. This speed is typically stated in Megabits (1,000,000 bits) per second or Gigabits (1,000 Megabits) per second.

FIXED WIRELESS. Fixed wireless is the operation of wireless communication devices or systems used to connect two fixed locations with a radio or other wireless link. Fixed wireless is part of a wireless LAN infrastructure. The purpose of a fixed wireless link is to enable data communications between the two sites or buildings.

FIBER OPTICS. The technology of guiding and projecting light for use as a communications medium. Hair-thin glass fibers that allow light beams to be bent and reflected with low levels of loss and interference are known as "glass optical wave guides" or simply "optical fibers."

This cable comes in two types, single mode and multimode, each with its own unique place in communications. Single mode FO cable is typically used where long distances and very high speeds are required, while multimode is used for intra-building communications and places where lower bandwidths are required.

FIBER/FIBER-OPTIC CABLE. A cable containing one or more optical fibers. Fiber-optic cable, also known as an optical-fiber cable, is an assembly similar to an electrical cable, but contains one or more optical fiber(s) that are used to carry light. The optical fiber elements are typically individually coated with plastic layers and contained in a protective tube suitable for the environment where the cable is used.

INCUMBENT LOCAL EXCHANGE CARRIER (ILEC). An ILEC is the local telephone company that provides service to business, organizations, and residences within the LATA. The ILEC is responsible for the development, maintenance, and support of cabling infrastructure necessary to provide telecommunications services within the LATA.

INTERNET. A widely used public computer network, initially developed by the U.S. military that links smaller computer networks and allows users on different electronic-mail systems to communicate with one another on a global scale.

INTERNET PROTOCOL (IP). In TCP/IP, a connection Internet layer protocol that provides a best-efforts datagram delivery service. Note the functional layer (TCP/IP) corresponds to the OSI model network layer. The Internet layer provides routing and relaying functions that are used when data must be passed from a host to some other network in the Internet. It operates in the source and destination hosts and in all the routers along the path between the hosts.

ISP (Internet Service Provider). A company that provides access to the Internet to individuals or companies. Some ISPs lease connections from Internet backbone providers.

LANDLINE. Traditional wired phone service.

LAST-MILE. Last Mile is used to describe the final connection to a building, as differentiated from the high-capacity circuits extending across a city or City. The connection from the cable television trunk cable to your house is considered a "last-mile" connection.

Mbps. Broadband speeds are measured in **'megabits per second'**, often shortened to Mbps. Bits are tiny units of data, with a megabit representing a million of them. The higher the number of Mbps (megabits per second) you have, the higher speed your online activity should be.

NETWORK. Any connection of two or more computers that enables them to communicate. Networks may include transmission devices, servers, cables, routers, and satellites. The phone network is the total infrastructure for transmitting phone messages.

RF (Radio Frequency). RF refers to the electromagnetic waves operating between 10KHz and 3MHz propagated without guide (wire or cable) in free space.

RIGHT-OF-WAY. Right of Way (ROW) refers to a designated space alongside a street or other access (such as a railroad line). An entity wishing to install fiber optic cable between various sites/locations must first obtain the rights to a path along those routes. As the cable may be installed underground or on poles, right-of-way access may be granted by a city, a private landowner, or the owner of poles such a cable company, a telephone company or power company. Cities typically require written permits— usually for a fee.

SATELLITE. The purpose of communications satellites is to relay the signal around the curve of the Earth allowing communication between widely separated geographical points. Communications satellites use a wide range of radio and microwave frequencies.

SERVICE PROVIDER. A telecommunications provider that owns circuit switching equipment.

UPLOAD SPEED. The rate at which data is transferred from the user's computer to the Internet is termed upload speed. This speed is typically stated in Megabits (1,000,000 bits) per second or Gigabits (1,000 Megabits) per second.

WAN (Wide Area Network. WAN is used to extend LAN connectivity beyond a city or City, usually through common carrier facilities.

WIRELESS. Wireless describes a means of sending signals (voice, video, or data) "over the air" rather than using cables. To date, wireless bandwidth rates (capacities) are significantly lower than wire rates. There are significant new developments in wireless, many of which will come to market in 2021 and beyond.